VIEW FROM BELGUA POINT, CHUGACH STATE PARK. PHOTO BY FRANK K.

Risk Report

FEMA Region X – Municipality of Anchorage, Alaska

Municipality of Anchorage

FEMA

DEPARTMENT OF COMMERCE, COMMUNITY AND ECONOMIC DEVELOPMENT

ALASKA GEOLOGICAL AND GEOPHYSICAL SURVEYS

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Executive Summary

This Risk Report discusses risk for the Municipality of Anchorage and, where data was available, for the communities of Anchorage, Chugiak, Eagle River, Girdwood, and Indian; the Alaska Bureau of Land Management; Chugach State Park; Chugach National Forest; Elmendorf Air Force Base; and Fort Richardson Military Reservation. The Report has two goals: (1) inform communities of their risks related to natural hazards; and (2) enable communities to take action to reduce their risks. State and local officials can use the data provided here to update local plans, communicate risk, inform modifications to development standards, identify mitigation projects, and ultimately take action to reduce risk.

This Risk Report showcases the results of an in-depth risk assessment of flood, earthquake, avalanche, dam failure, landslide, wind, and wildfire hazards in the Municipality of Anchorage performed by the Federal Emergency Management Agency (FEMA) as part of a Risk Mapping, Assessment, and Planning (Risk MAP) program project. The risk assessment analyzes how a hazard affects the built environment, population, and local economy, and is used as the basis for developing mitigation strategies and identifying mitigation actions to make communities more resilient against future hazards.

A FEMA project team completed the risk assessments discussed in this Risk Report using a free FEMA risk assessment tool, Hazus, which estimates losses due to earthquake scenarios for specific buildings. Where data were available, a list of buildings in the Municipality of Anchorage was incorporated into the Hazus model. The project team assessed flood, avalanche, dam failure, landslide, wind, and wildfire hazards by performing an exposure assessment. To assess potential community losses, the team collected information on local assets or resources at risk from certain hazards, the physical features and human activities that contribute to that risk, and the location and severity of the hazard. The loss data from Hazus and the exposure assessment highlight areas that would be affected, which provides local officials with an opportunity to prioritize mitigation actions in these areas.

Flood Exposure Assessment

In the Municipality of Anchorage, the project team modeled flood losses at $376 million. At 6.94 percent, the area of Girdwood has the highest economic loss ratio of structures in the Special Flood Hazard Area (SFHA), the area subject to inundation by the base (1-percent-annual-chance) flood. The Municipality of Anchorage has the largest total estimated building and content losses, at over $329 million.

Earthquake Risk Assessment

The project team based the earthquake assessments on the Magnitude (M) 7.1 earthquake event (referred to as M7.1 Border Ranges Scenario), M7.2 Intraplate Scenario, and M7.5 Castle Mountain Scenario created to simulate the estimated potential loss in regard to each identified event. The team estimated building and content losses at $951 million for the M7.1 Border Ranges Scenario, $468 million for the M7.2 Intraplate Scenario, and $383 million for the M7.5 Castle Mountain Scenario. For all scenarios, the team projects that the heaviest losses would occur in the Municipality of Anchorage, with estimated building and content losses of $616 million for the M7.1 Border Ranges Scenario, $423 million for the M7.2 Intraplate Scenario, and $336 million for the M7.5 Castle Mountain Scenario, respectively. The team also projected losses for transportation systems (highways, railways, ferries, ports, and airports), utility systems (potable water, wastewater, oil systems, natural gas, electric power, and communication facilities), and essential facilities (educational, fire, government, health care, and police).

Avalanche Exposure Assessment

The project team based the avalanche assessment for the Municipality of Anchorage on the Anchorage Snow Avalanche Zoning Analysis, which was prepared for the Municipality of Anchorage by Arthur Mears, P.E., September 1982. This study provides a methodology for defining high and moderate avalanche hazards, and delineates the general boundaries of these hazard areas on maps of the Anchorage Bowl, Chugiak-Eagle River, and Turnagain Arm/Girdwood areas. The project team assessed the amount of structures within avalanche hazard areas and the total estimated value of the building and contents exposure to the identified hazard. The team identified 206 structures within avalanche hazard areas, which is 2.06 percent of the total number of buildings within the Municipality of Anchorage. The team estimated that the building value exposed to avalanche hazard areas is over $48 million, with a 0.002 percent of building loss due to avalanche hazard area exposure.

Dam Failure Exposure Assessment

The project team performed a dam failure risk assessment for the Eklutna Lake Inundation Area, Lake 'O' the Hills Dam Inundation Area, and Lower Fire Lake Inundation Area. Of the three identified dam failure risk areas, the team identified 169 structures as being at risk of inundation. In total, the team estimated that almost $24 million in building and content values are at risk, including many commercial, residential, and community facilities in Eagle River.

Landslide Exposure Assessment

The project team based the assessment of landslide hazard areas on two type of landslide zones: the deep, transitional landslide zone and the shallow landslide zone. The team projected that approximately $6.3 billion in building and content values (5,092 improved parcels) in the studied communities are at risk from a landslide hazard occurrence. Most of the at-risk structures were in the deep, transitional landslide zone, accounting for 0.11 percent of building exposure. The team projected that Anchorage and the Elmendorf Air Force Military Reservation will receive the most impact from a landslide hazard occurrence.

Wind Exposure Assessment

High wind events have been identified as a hazard occurrence within the Municipality of Anchorage. To accurately estimate high wind hazard vulnerability, the project team used three zones to estimate damage amounts. Zone I, Zone II, and Zone III were identified based on 3-second gust wind speeds of between 100 miles per hour (mph) and 125 mph. The majority of the estimated loss occurs within the Municipality of Anchorage, with $11 billion dollars of estimated loss during a Zone I hazard event.

Wildfire Exposure Assessment

The project team must still determine what wildfire hazard data are available for the Municipality of Anchorage. The total number of buildings within the Municipality of Anchorage is 85,464, with an estimated total value of over $65 billion. The location of structures in relation to wildfire risk areas will impact the number of buildings vulnerable to wildfire hazard events and the number of losses associated with potential hazard events.

Using the Risk Assessment and Exposure Assessment Results

The results of this risk assessment, including the loss data from Hazus, the exposure assessment, and the design code analyses, highlight the areas most affected by the hazards noted above. State and local officials should use this information to identify areas for mitigation projects, as well as for additional outreach efforts to educate residents on the hazards that affect the Municipality. The areas of greatest

hazard impact are identified in the *Areas of Mitigation Interest* section of this Risk Report, which can serve as a starting point for identifying and prioritizing actions communities can take to reduce risks.

1. Introduction

This Risk Report summarizes the risk assessment results and findings for the Federal Emergency Management Agency's (FEMA) Risk Mapping, Assessment, and Planning (Risk MAP) study. All results, databases, and maps used to generate this Risk Report are provided in the Risk Assessment Database included with this Risk Report. This Risk Report has two goals: (1) inform communities of their risks related to certain natural hazards, and (2) enable communities to act to reduce their risk. State and local officials can use the summary information provided in this Risk Report, in conjunction with the data in the risk database, to do the following:

- **Update local hazard mitigation plans (HMPs), and community comprehensive plans** – Planners can use risk information when developing or updating HMPs, comprehensive plans, future land use maps, and zoning regulations. For example, zoning codes can be changed to provide for more appropriate land uses in high-hazard areas.
- **Update emergency operations and response plans** – Emergency managers can identify low-risk areas for potential evacuation and sheltering. Risk assessment information may show vulnerable areas, facilities, and infrastructure for which planning for continuity of operations plans, continuity of government plans, and emergency operations plans would be essential.
- **Communicate risk** – Local officials can use the information in this Risk Report to communicate with property owners, business owners, and other citizens about risks and areas of mitigation interest (AOMIs).
- **Inform the modification of development standards** – Planners and public works officials can use information in this Risk Report to support the adjustment of development standards for certain locations.
- **Identify mitigation projects** – Planners and emergency managers can use this risk assessment to determine specific mitigation projects. For example, a floodplain manager may identify critical facilities that need to be elevated or removed from the floodplain.

The intended audience for this Risk Report includes, but is not limited to, the following:

- Local Elected Officials
- Community Planners
- Emergency Managers
- Public Works Officials

2. Risk Assessment and Exposure Assessment

A risk assessment analyzes how hazards affect the built environment, population, and local economy by using the Hazus risk assessment tool. Where data necessary for the Hazus tool was limited, exposure assessments were developed to capture similar hazard affects to life, property, and the economy. In hazard mitigation planning, risk assessments and exposure assessments are the basis for mitigation strategies and actions. Risk assessments and exposure assessment defines the hazard and enhances the decision-making process. The FEMA project team completed the flood risk assessment summarized in this Risk Report using a free FEMA risk assessment tool, Hazus, which estimated earthquake losses for specific buildings. The team incorporated a complete list of buildings in the Municipality of Anchorage into the

Hazus model. The team assessed other hazards by performing an exposure assessment: a process of identifying whether a property is at risk to a mapped hazard. To assess potential community losses, the team collected the following information:

- Local assets or resources at risk to the hazard;
- Physical features and human activities that contribute to that risk; and
- Location and severity of the hazard.

This Risk Report contains information on seven types of risk assessments to help individuals describe and visualize the risk for a variety of hazards at the jurisdictional levels:

1. Flood Risk Assessment: Exposure Assessment
2. Earthquake Risk Assessment: Hazus Estimated Loss Information
3. Avalanche Risk Assessment: Exposure Assessment
4. Dam Failure Risk Assessment: Exposure Assessment
5. Landslide Risk Assessment: Exposure Assessment
6. Wind Risk Assessment: Exposure Assessment
7. Wildfire Risk Assessment: Exposure Assessment

For the purposes of this assessment, economic loss is summarized for non-vacant parcels where at least one structure has been identified. Parcels with at least one structure are referred to throughout this Risk Report as "improved parcels." Additionally, total values and economic losses consider the replacement value of the building and its contents. The appendix provides detailed information on the risk assessment methodology.

3. Municipality of Anchorage Risk MAP Overview

FEMA and the State of Alaska have funded a Risk MAP Project to assess the risk posed by a variety of natural hazards. The FEMA Production and Technical Services provider, the Strategic Alliance for Risk Reduction (STARR); the FEMA Community Engagement and Risk Communication provider, *Resilience Action Partners*; and the Alaska Department of Community and Regional Affairs are contributors to this project. The projects summarized below were scoped for this risk assessment.

Seismic Hazus Run and Analysis

FEMA, the Municipality of Anchorage, and the Alaska Division of Geological and Geophysical Survey (DGGS), has worked together to complete the Hazus risk assessment for the three earthquake scenarios listed below.

M7.5 Castle Mountain Scenario

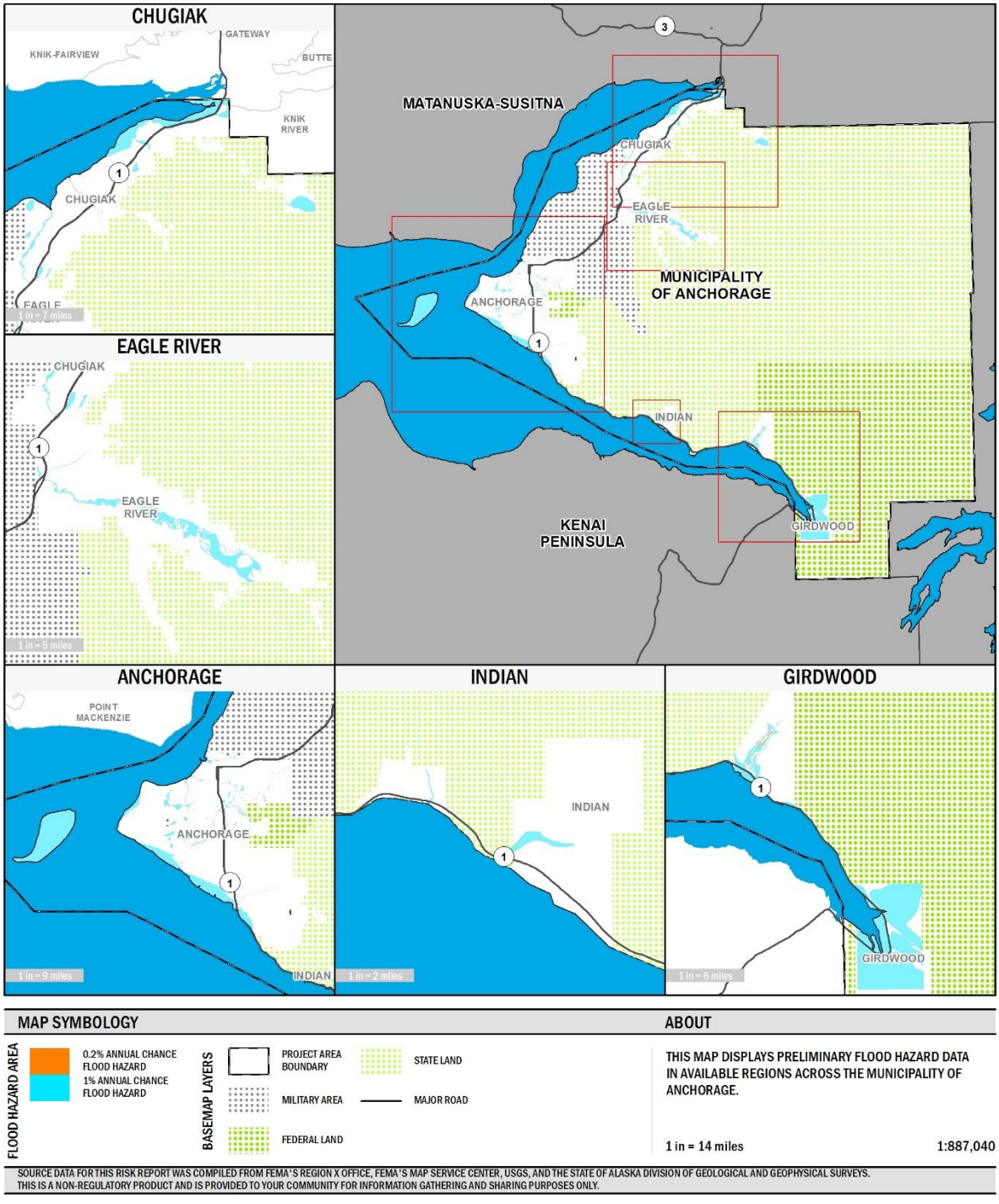
M7.2 Intraplate Scenario

M7.1 Border Ranges Scenario

Avalanche, Dam Failure, Flood, Landslide, Wildfire, Wind Vulnerability Exposure Assessment

FEMA has completed an exposure assessment using Municipality of Anchorage, State, and Federal data and will recommend mitigation strategies based on the results. FEMA has identified vulnerable infrastructure and essential facilities based on results from the Geographic Information System (GIS)-based assessment. FEMA has develop AOMIs in coordination with the Municipality of Anchorage.

Map 1: Overview of the Municipality of Anchorage



4. Socioeconomic Vulnerability

Risk assessments are characterized by an analysis of the physical extent of hazards and their corresponding locations. However, it is important to highlight additional factors that play a role in a community's ability to be resilient after a natural disaster, and the feasibility of enacting mitigation actions. Socioeconomic factors can both amplify and dampen the community's susceptibility to loss, and understanding these factors can help communities allocate resources effectively and equitably to more vulnerable populations. Individuals' ability to prepare and respond to hazards will affect evacuation times and their ability to reach recovery centers and to afford hazard prevention techniques and repairs to their homes and properties.

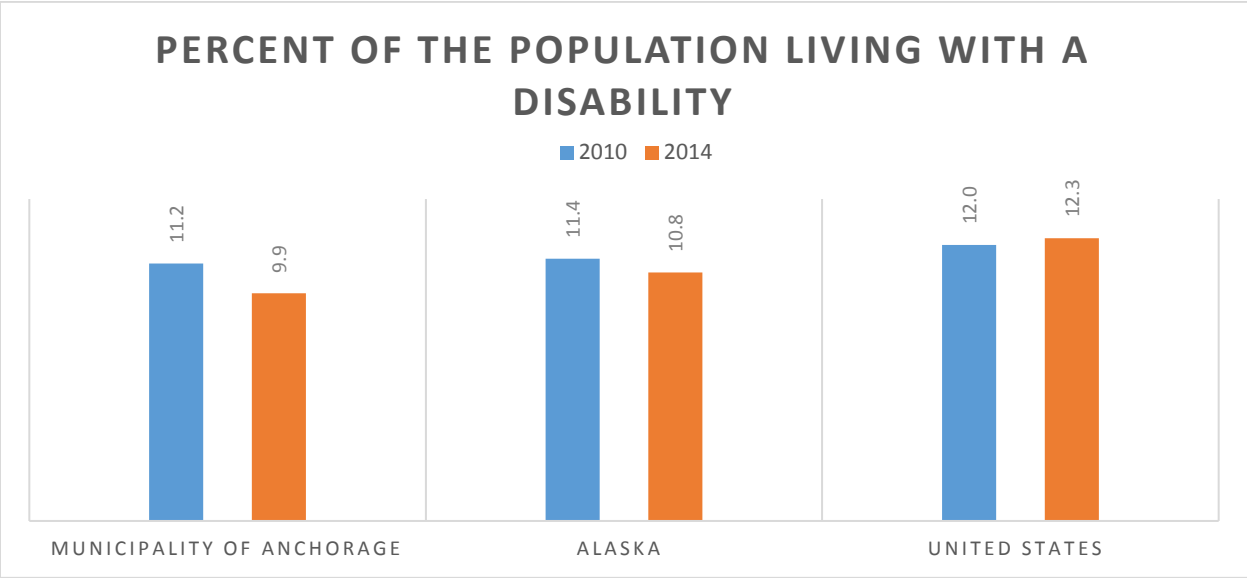
An understanding of the population of the Municipality of Anchorage, relative to State and national populations, and how that population is changing over time is necessary to effectively improve existing communication programs that target individuals at risk from the natural hazards that affect the area. Demographic data, which are analyzed below, were obtained from the U.S. Census Bureau and are searchable through the American Fact Finder advanced search. Data from 2000 and 2010 are provided through those years' census counts. Statistics provided in 2014 are from the American Community Survey, which is an ongoing statistical survey conducted by the U.S. Census Bureau. While most data are available for the years listed above, some socioeconomic statistic data was limited and not included in every discussion.

Vulnerable Population Groups

People over the age of 65 or under the age of 18 are classified as vulnerable age groups. These individuals may depend on others or on assistive devices to fulfill the activities of daily living. Children rely on caregiving adults, while elderly populations may have transportation and mobility limitations. In the Municipality of Anchorage, 25.4 percent of residents were under the age of 18 in 2014, compared to 25.8 percent in Alaska, and 23.5 percent nationwide. Elderly residents accounted for 8.1 percent of the Municipality population, compared to 8.5 percent in Alaska, and 13.7 percent nationwide. Between 2000 and 2014, the population under the age of 18 decreased, while the number of individuals over the age of 65 increased.

Additionally, individuals characterized as living with a disability may require more equitable services with regard to hazard presentation, preparation, mitigation, and repairs. The percentage of residents living with a disability in the Municipality of Anchorage was below both the State and national percentages (Figure 1) and decreased between 2010 and 2014.

Figure 1: Percentage of the Population Living with a Disability



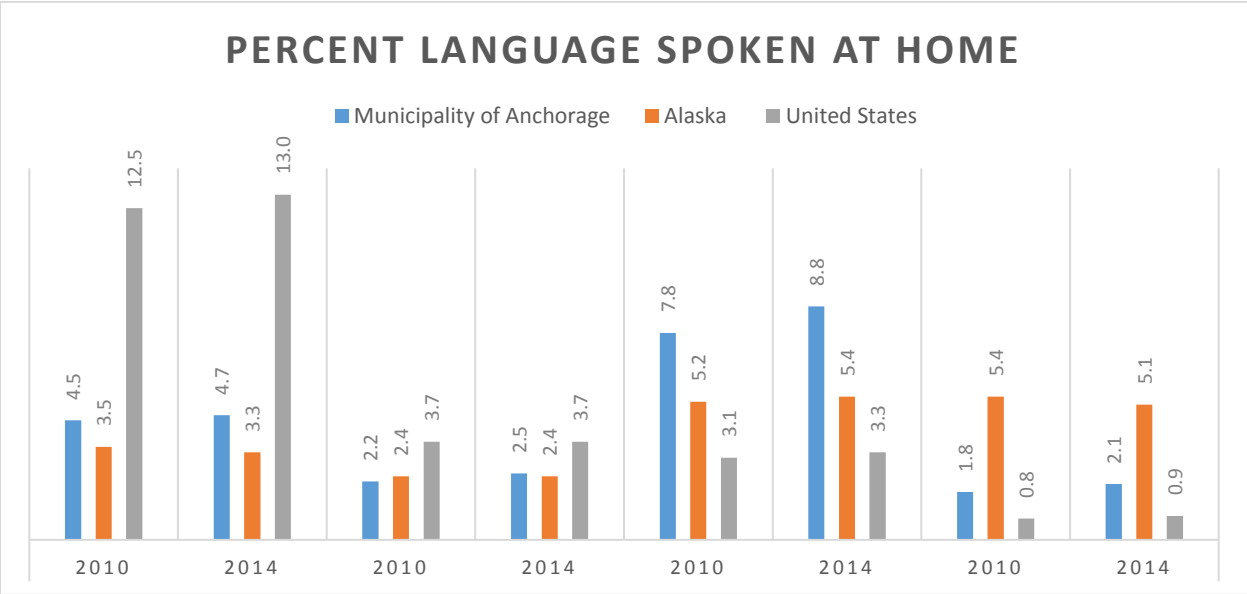
Culture and Language

The U.S. Census Bureau categorizes the language spoken at home in five main categories: English, Spanish, other Indo-European languages, Asian and Pacific languages, and other languages. Cultural and linguistic differences can have a negative impact on natural hazard communication and outreach efforts. Approaching hazard mitigation and response efforts with a comprehensive understanding of cultural behaviors, attitudes, and language barriers will increase the success rates of hazard prevention, preparation, and response in culturally diverse communities.

Within the Municipality of Anchorage, the majority of the population speaks English. When compared to the total population of the United States, both the Municipality of Anchorage and Alaska have fewer Spanish speakers than the United States; however, the percentage of Spanish speakers in Anchorage is higher than the percentage of Spanish speakers statewide. In the Municipality, the largest percentage of non-English-speaking residents speak Asian and Pacific languages at home, which can be attributed to the larger populations of Filipino, Korean, and Hmong residents. While the majority of residents living in the Municipality of Anchorage speak English, the percentage of Asian and Pacific language-speaking residents is higher than both the State and national averages.

Communicating risk to communities may present some language barriers. Ideally, all jurisdictions should approach community engagement and risk communication with cultural competency to ensure that outreach and education efforts reach all communities equitably.

Figure 2: Percentage of Non-English Languages Spoken



Economic Vulnerability

Knowing the economic characteristics of a community can assist in the analysis of the community's ability to prepare, respond, and rebuild after a natural hazard. Categorizing economic vulnerability can encompass many factors, including median household income, poverty rates, employment and unemployment rates, housing tenure, and community building inventory.

Median household income and poverty rates measure individual economic stability. Communities with a larger portion of their population living from paycheck to paycheck may have more individuals finding it difficult to rebuild after a disaster. Alternatively, wealthier communities may be less affected by a disaster because they have the financial means to prepare, prevent, and rebuild stronger after a disaster. In 2014, the Municipality of Anchorage median household income was approximately $24,500 higher than the median household income nationwide (Figure 3), and the poverty rate for the Municipality was over 7 percent lower than the national rate (Figure 4).

Figure 3: Median Household Income between 2000 and 2014 (in 2014 Dollars)

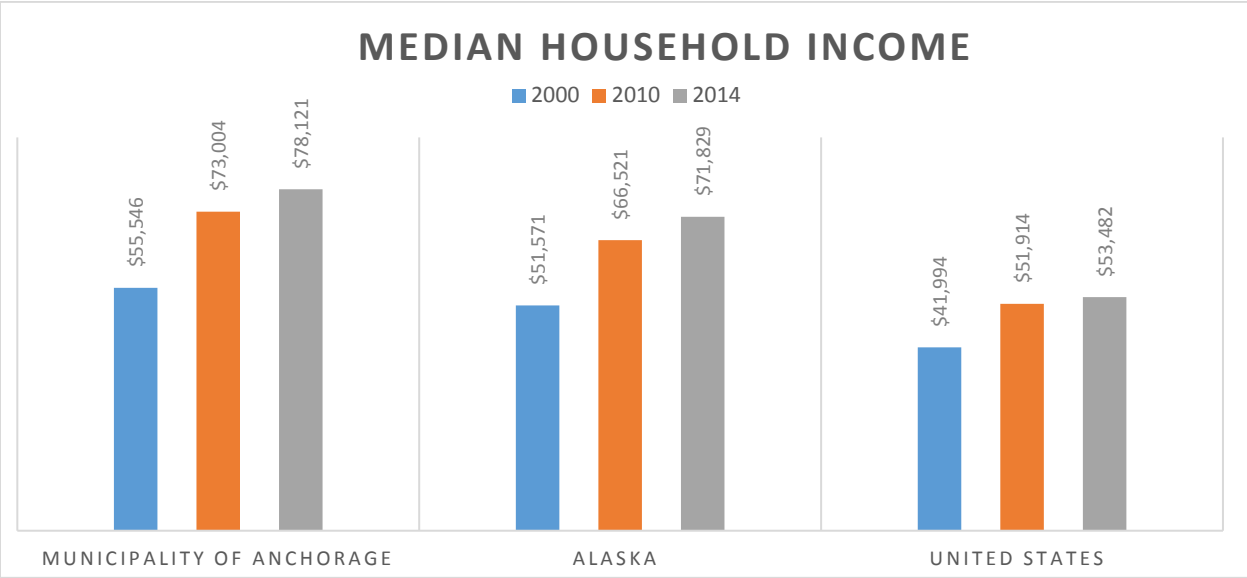
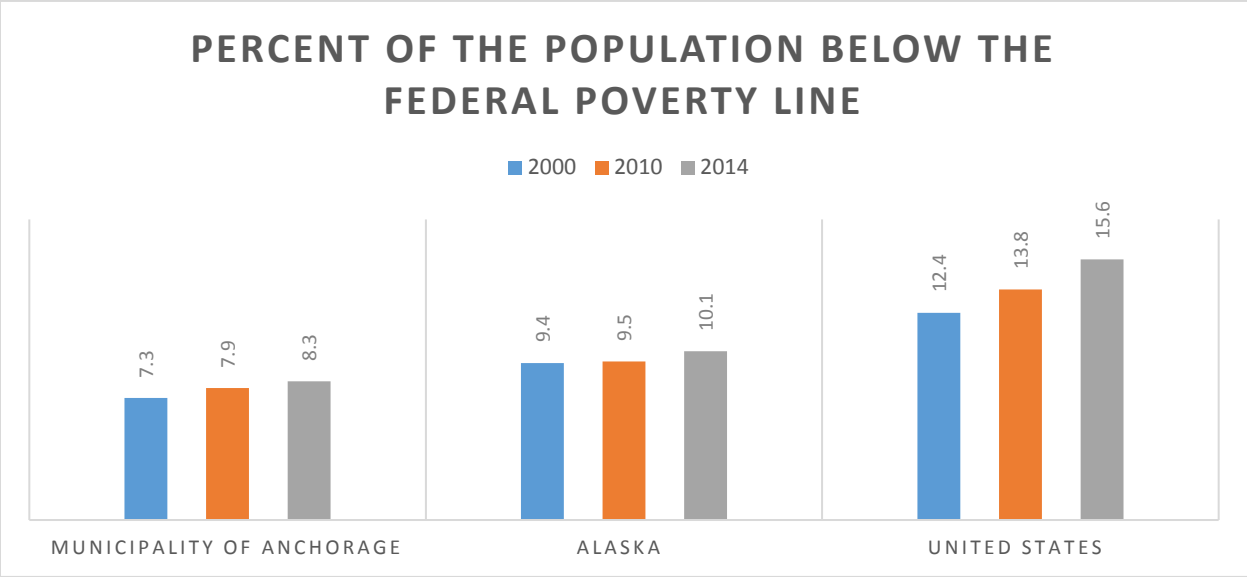
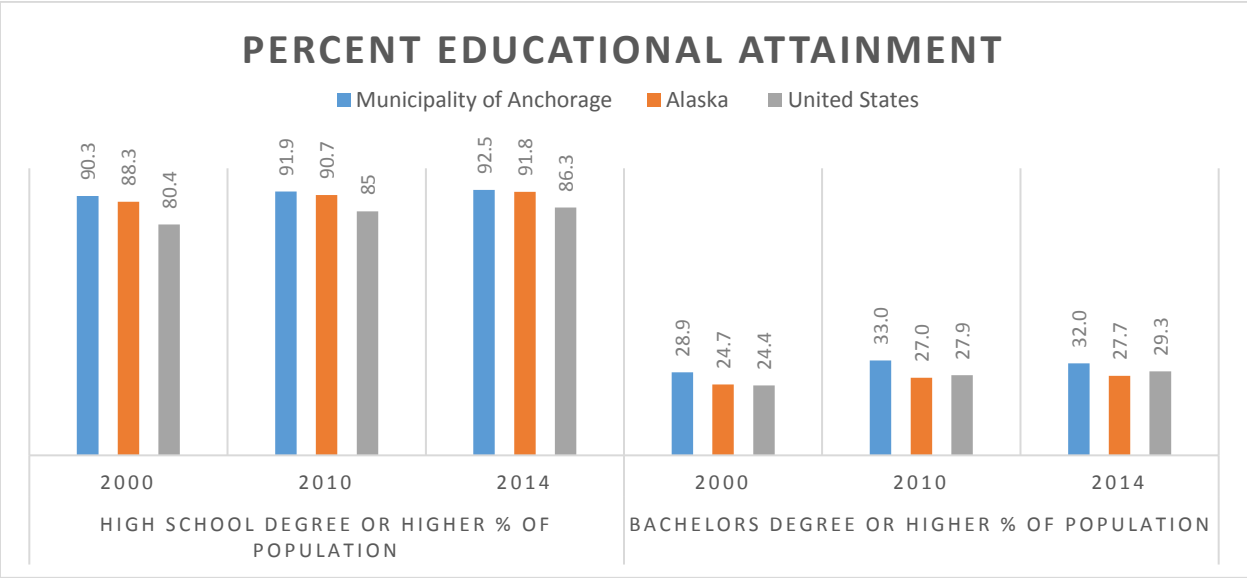


Figure 4: Percentage of Population Living below the Poverty Line between 2000 and 2014



Educational attainment is a measure of how many individuals have received a high school degree or higher, or a bachelor's degree or higher. Obtaining a higher education may result in higher wages and more financial stability. When compared to the nationwide percentage of the population obtaining a high school degree or higher, the Municipality of Anchorage consistently had a higher percentage of individuals obtain a high school degree and a bachelor's degree when compared to both Alaska and the United States (Figure 5). Additionally, the percentage of educational attainment steadily increased between 2000 and 2014 within the Municipality of Anchorage.

Figure 5: Percentage of Population with High School Degree or Higher Between 2000 and 2014

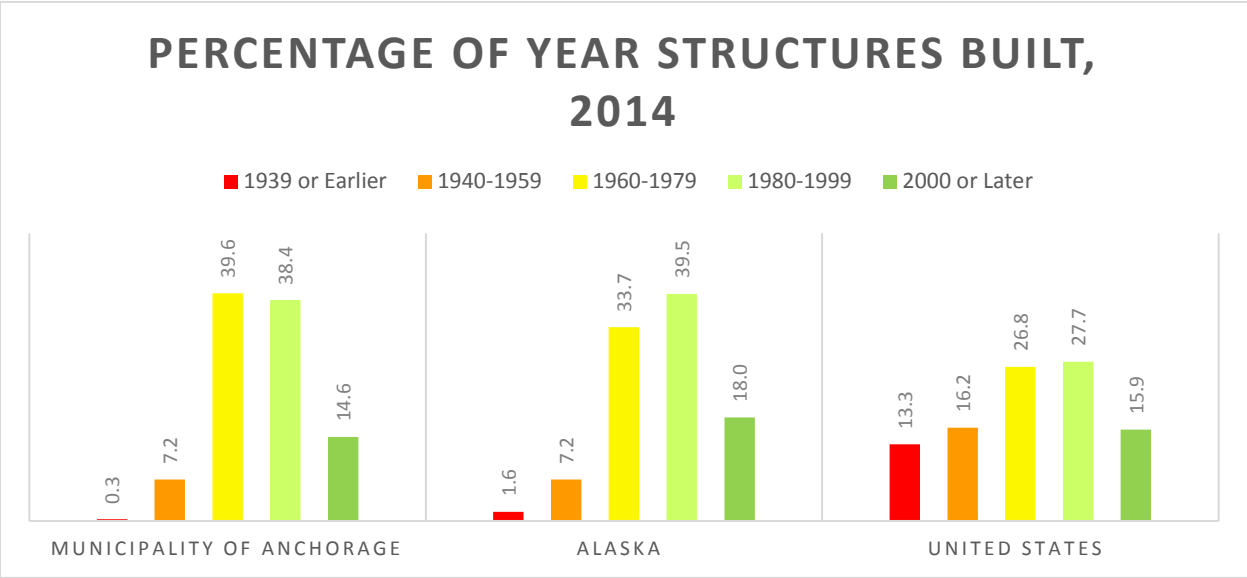


With the majority of the population living above the poverty line, more individuals are homeowners. Homeownership allows individuals to make structural alterations to their homes to prepare for disasters and prevent potential damage. In 2014, only 59.8 percent of Municipality of Anchorage residents owned their home, while 40.2 percent were renters. Of the renters, 36.2 percent of individuals were spending more than 35 percent of their income on rent. Spending more of their income on rent may prevent these individuals from having the financial ability to prepare for natural disasters, access reliable transportation, and rebuild stronger after a hazard event.

Economic sustainability is encouraged through employment and job security. The higher the employment rate, the more financial stability is accomplished on an individual level. In addition, a healthy job market brings economic growth to communities. In 2014, the employment rate in the Municipality of Anchorage was almost 8 percent higher than the national employment rate. Additionally, the unemployment rate for the Municipality of Anchorage was 6.9 percent in 2014, lower than 8.4 percent statewide and 9.2 percent nationwide.

Communities with more economic growth are able to invest in new development and retrofitting projects to increase the resilience of their buildings and infrastructure. In 2014, the Municipality of Anchorage reported that a higher percentage of its buildings had been built after 1960. Additionally, when compared with Alaska and the Nation, the Kenai Peninsula Borough had the lowest percentage of buildings built between 1940 and 1959, and the lowest percentage of buildings built before 1940 (Figure 6). The economic growth in the Municipality of Anchorage has resulted in building stock that may be more resilient to natural hazards.

Figure 6: Building Stock by Time Period



Socioeconomic Conclusion

Learning more about how to communicate multi-hazard risk information effectively to residents is crucial when implementing hazard mitigation strategies. With the available demographic information, FEMA can assist community representatives in establishing better connections and delivery methods to keep the public informed, engaged, and aware of the risks presented by multiple hazards in the area, while understanding the audience FEMA would like to reach.

5. Flood Exposure Assessment

Flood Hazard Overview

The Municipality of Anchorage identified 13 sources of flooding that could occur independently or together. Flooding could result from heavy rainfall, urban stormwater overflow, rapid snowmelt, rising groundwater, chronic debris deposition, ice jamming, flash flooding, fluctuating lake levels, alluvial fan flooding, glacial lake outbursts, subglacial release, coastal storm surges, and tsunamis.

The varying sources of local flooding make this hazard a regular occurrence in the region. The Municipality of Anchorage All Hazards Mitigation Plan tracks historical flood events back to the late 1940s and highlights several flood events along Campbell, Chester, Eagle, Glacier, Meadow, Peters, Rabbit, and Ship Creeks, and Lake George. The three flood events that received Presidential Disaster Declarations, with the most recent occurrence in 2005, are highlighted in the following paragraphs.

Table 1: Presidentially Declared Flood Disaster History for the Municipality of Anchorage

DISASTER NUMBER	DECLARATION DATE	DISASTER TYPE	INCIDENT TYPE	TITLE	INCIDENT BEGIN DATE	INCIDENT END DATE
1618	12/09/2005	DR	Flood	Severe Fall Storm, Tidal Surges, and Flooding	09/22/2005	09/26/2005
1072	09/1995	DR	Flood	FLOODING	09/18/1995	10/10/1995
832	08/30/1989	DR	Flood	FLOODING	05/01/1989	06/10/1989

DR-1618

On September 22, 2005, Federal disaster aid was made available to the State of Alaska to support State, tribal, and local recovery efforts in the Municipality of Anchorage areas affected by flooding on September 22-26, 2005. In addition to Public Assistance funding, $195,810.00 was made available statewide through the FEMA Hazard Mitigation Grant Program (HMGP), however, no funds were specifically allocated to the Municipality of Anchorage. The purpose of the HMGP is to help communities implement hazard mitigation measures following a Presidential major disaster declaration. Hazard mitigation is any action taken to reduce or eliminate long-term risk to people and property from natural hazards.

Table 2: DR-1618 Public Assistance - Dollars Approved

	TOTAL PUBLIC ASSISTANCE GRANTS - DOLLARS OBLIGATED*	EMERGENCY WORK (CATEGORIES A-B) - DOLLARS OBLIGATED*	PERMANENT WORK (CATEGORIES C-G) - DOLLARS OBLIGATED*
Total Amount	$1,415,493.42	$144,537.96	$1,179,241.37

DR-1072

On September 18, 1995, Federal disaster aid was made available to the Municipality of Anchorage due to flooding caused by heavy rainfall. Most of the damage occurred outside the Municipality of Anchorage, but Girdwood was negatively impacted. The wastewater treatment plant in Girdwood was shut down due to being overwhelmed by large volumes of mud and water. This resulted in raw sewage being washed into local creeks. No FEMA-based financial assessments are publicly available, and while HMGP funding was distributed statewide, not funds were allocated specifically for the Municipality.

DR-832

On August 30, 1989, FEMA made Federal disaster aid available to the Municipality of Anchorage following a series of rainstorms. The Municipality of Anchorage had more than 5 inches of rainfall, causing heavy flooding along drainage systems. The flooding was concentrated at homes and businesses along Campbell, Chester, and Ship Creeks. The flooding resulted in a State Disaster Declaration. No FEMA-based financial assessments are publicly available, and while HMGP funding was distributed statewide, not funds were allocated specifically for the Municipality.

Studying Flood Hazards

FEMA created a digital Flood Insurance Rate Map for the Municipality of Anchorage in 2009, using existing U.S. Army Corps of Engineers work maps, to regulate and manage flood hazards in Anchorage, Chugiak, Eagle River, Girdwood, Indian, and other regions within the Municipality of Anchorage. SFHAs based on existing modeling were mapped for the Cities of Anchorage, Chugiak, Eagle River, and Girdwood. Portions of the Municipality of Anchorage are mapped as Zone D. The Zone D designation is used for areas where there are possible but undetermined flood hazards, as no assessment of flood hazards has been conducted.

Flood Exposure Assessment Overview

This flood exposure assessment includes the communities shown in Table 3:

Table 3: Community Characteristics in the Municipality of Anchorage

COMMUNITY NAME	TOTAL POPULATION (2015 EST.)	CRS COMMUNITY	FLOOD CLAIMS	REPETITIVE LOSS PROPERTIES	TOTAL POLICIES	TOTAL INSURANCE COVERAGE
Municipality of Anchorage	298,695	YES-6	63	2	457	$127,149,800

State and local officials can use the information in Table 3 to highlight communities that are already affected by flooding, including repetitive loss properties and flood claims. In addition, the officials can compare the insurance coverage to the dollar losses shown in

Table 4 to determine if enough coverage exists for a specific event.

The project team completed a flood risk exposure assessment with individual parcel data provided by the Municipality of Anchorage. The project team incorporated only properties with buildings (improvements) into the analysis; therefore, no impacts to vacant land were assessed. For this assessment, buildings that intersected a mapped SFHA (Zones A, AE, AH, or AO) are summarized.

Table 4 highlights the building value and loss ratios of parcels within the floodplain, by region.

Table 4: SFHA Assessments in the Municipality of Anchorage

COMMUNITY NAME		BUILDINGS IN FLOOD ANALYSIS*	BUILDINGS IN ZONE A, AE, AH, AO	PERCENT BUILDINGS IN ZONE A, AE, AH, AO	BUILDING VALUE (BUILDING AND CONTENTS) IN FLOOD ANALYSIS	BUILDING VALUE EXPOSURE IN ZONE A, AE, AH, AO	PERCENT BUILDING VALUE EXPOSURE IN ZONE A, AE, AH, AO
Municipality of Anchorage	Anchorage	71,430	328	0.46%	$57.5B	$329.2M	0.57%
	Chugiak	2,896	3	0.10%	$1.7B	$1.0M	0.06%
	Eagle River	9,038	30	0.33%	$4.8B	$10.3M	0.21%
	Girdwood	1,388	71	5.12%	$513.7M	$35.7M	6.94%
	Indian	130	---	---	$69.0M	---	---
AK Bureau of Land Management		496	---	---	$417.4M	---	---
Chugach State Park		---	---	---	---	---	---
Chugach National Forest		---	---	---	---	---	---
Elmendorf Air Force Base		---	---	---	---	---	---
Fort Richardson Military Reservation		---	---	---	---	---	---
TOTAL		**85,378**	**432**	**0.01%**	**$65.1B**	**$376.3M**	**0.58%**

Note: Dollar losses are reported, as well as a loss ratio, which is calculated as the total building losses/total building value. Also included is a count of parcels in Zone VE, which is the 1-percent-annual-chance coastal high hazard flood zone, as well as the buildings in Zones A, AE, AO, and AH, which are riverine and/or coastal 1-percent-annual-chance floodplains. The loss values are for buildings only; additional damages to infrastructure are not captured in this table.

*Structures residing in Zone D were not included for this assessment

The preliminary flood hazard data available for select locations throughout the Municipality of Anchorage allowed for a partial flood risk analysis. No flood hazard areas have been mapped for Chugach State Park, Chugach National Forest, Elmendorf Air Force Base, or Fort Richardson Military Reservation, but flood hazard data are available for many inhabited regions of the Municipality of Anchorage. The exposure flood analysis was based on the 432 structures identified within a mapped flood hazard area. A majority of those buildings are in the Anchorage Bowl (referred to as Anchorage throughout this Risk Report). Located in the eastern area of the Municipality of Anchorage, Anchorage has 71,430 improved parcels available for analysis and 328 of those parcels were identified as being located the mapped SFHA. In Girdwood, 71 identified structures are within the mapped SFHA. In Eagle River, has 30 structures are within the mapped SFHA.

A large portion of the flood risk exposure assessment focused on flood losses due to riverine flooding. Of the 85,378 buildings, 432 are in Zones A, AE, AH, or AO. The highest projected building losses are in Anchorage, which accounts for almost 75 percent of the losses in the Municipality. An estimated $376 million worth of at-risk facilities could be lost in a riverine flooding event. A $376 million loss accounts for a 0.58-percent loss ratio of the studied buildings. Other vulnerable areas include Anchorage, with a projected $329 million loss, Girdwood with a projected $35 million loss, and Eagle River with a projected

$10 million loss. In communities with more than one structure at risk, loss ratios of 6.94 percent in Girdwood and 0.57 percent in Anchorage were the highest in the Municipality of Anchorage.

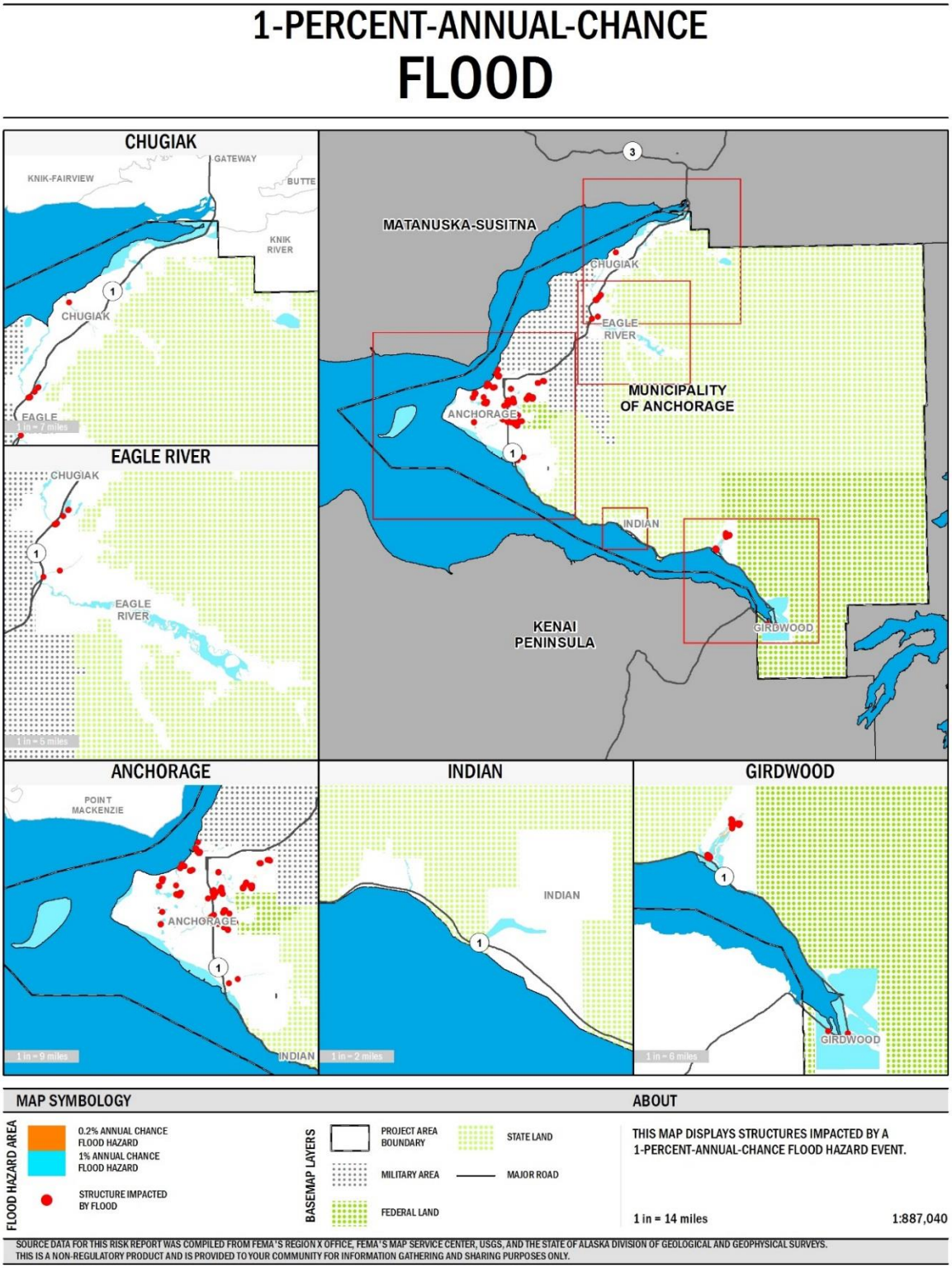
When comparing structures at risk in

Table 4 to insurance policies in Table 3, the number of flood insurance policies in the Municipality of Anchorage (457) is higher than the number of properties in the mapped SFHA (432). Communities look to have a comparable level of insurance for their risk.

The community results shown above give an idea of where the largest flooding concerns are. This exposure assessment includes information for every parcel in each community within a studied flood prone area, so local officials can use the results to determine which parcels in a community have the highest flood risk. Map 2 shows the potential losses during a 1-percent-annual-chance flood event for the coastal and riverine areas of the Municipality of Anchorage. Parcels shown in red and orange have the potential to be significantly damaged during a 1-percent-annual-chance flood event, based on the depth of flooding at their location and the height of the building.

Local officials can use the loss data from exposure assessment, which highlight the areas affected by flooding, to identify properties for mitigation projects, as well as areas to target for additional outreach. These areas of greatest impacts and potential mitigation actions are highlighted in Section 13, Areas of Mitigation Interest. All results, databases, and maps are provided in the Risk Assessment Database included with this Risk Report.

Map 2: Buildings Impacted by a 1-Percent-Annual-Chance Flood in the Municipality of Anchorage



6. Earthquake Risk Assessment

Earthquake Hazard Overview

The Municipality of Anchorage is subject to numerous earthquake events of varying magnitudes. The region faces significant risk from earthquakes resulting from the Pacific Plate subduction beneath the North American Plate. Since 1900, there have been 15 events having a magnitude greater than 4.0 that have had an epicenter within the Municipality of Anchorage boundary (AEIC).

The largest earthquake in the region occurred on March 27, 1964, and is known as the 1964 Great Alaska Earthquake. Within the Municipality of Anchorage, it has also been called the Good Friday Earthquake. This 9.2 Magnitude (M) earthquake is the largest ever recorded in North America and the second largest in the world. The shaking lasted between 4 and 5 minutes and was felt over an area of approximately 7 million square miles. The ground shaking caused a significant amount of ground deformation and triggered landslides and tsunamis. The Turnagain Heights landslide was the most damaging, with more than 100 homes destroyed. Most of the fatalities associated with this event were caused by the resulting tsunamis, not the earthquake (Anchorage All-Hazards Mitigation Plan Update, 2011). As shown in Table 5, two earthquake-related Presidential Disasters were declared in Alaska, and they are described below.

Table 5: Presidentially Declared Earthquake Disaster History for Alaska

DISASTER NUMBER	DECLARATION DATE	DISASTER TYPE	INCIDENT TYPE	TITLE	INCIDENT BEGIN DATE	INCIDENT END DATE
1440	11/2002	DR	Earthquake	EARTHQUAKE	11/3/2002	11/20/2002
168	3/1964	DR	Earthquake	EARTHQUAKE	03/28/1964	03/28/1964

DR-1440

On November 3, 2002, the 7.9M Denali earthquake struck Alaska with an epicenter roughly 150 miles north of Anchorage. The shock of the earthquake was the strongest ever felt in the interior of Alaska. Roads and bridges were damaged the most, as the area most effected by shaking and liquefaction was undeveloped. Both public and individual FEMA assistance grants were approved for affected Alaska communities. In addition to Public Assistance funding, nearly $3 million was made available statewide through the FEMA Hazard Mitigation Grant Program (HMGP), however, no funds were specifically allocated to the Municipality of Anchorage.

Table 6: DR-1440 Public Assistance - Dollars Approved

	TOTAL PUBLIC ASSISTANCE GRANTS - DOLLARS OBLIGATED*	EMERGENCY WORK (CATEGORIES A-B) - DOLLARS OBLIGATED*	PERMANENT WORK (CATEGORIES C-G) - DOLLARS OBLIGATED*
Total Amount	$1,415,493.42	$144,537.96	$1,179,241.37

Table 7: DR-1440 Individual Assistance - Dollars Approved

	TOTAL PUBLIC ASSISTANCE GRANTS - DOLLARS OBLIGATED*	EMERGENCY WORK (CATEGORIES A-B) - DOLLARS OBLIGATED*	PERMANENT WORK (CATEGORIES C-G) - DOLLARS OBLIGATED*
Total Amount	$1,415,493.42	$144,537.96	$1,179,241.37

ShakeMaps

Maps depicting the shaking intensity and ground motion produced by an earthquake, called ShakeMaps, can be produced in near-real time for events or created for specific scenarios by regional seismic network operators in cooperation with the U.S. Geological Survey. ShakeMaps can be used for response, land use, and emergency planning purposes. In this case, FEMA, the Municipality of Anchorage, and the DGGS, worked together to choose ShakeMaps for three earthquake scenarios:

1. M7.1 Border Ranges Scenario
2. M7.2 Intraplate Scenario
3. M7.5 Castle Mountain Scenario

The heaviest shaking and economic losses occurred during the M7.1 Border Ranges Scenario in areas northeast of the Municipality of Anchorage, including Eagle River and Chugiak; instrumental intensity in this area reached M7.8, defined as *strong* shaking. Instrumental intensity observed during the M7.2 Intraplate Scenario was highest to the east of Anchorage in the Cook Inlet, measuring M6.5. The M7.5 Castle Mountain Scenario produced shaking intensities of M6.6 to the west of Anchorage in the Cook Inlet.

Earthquake Risk Assessment Overview

The project team performed three earthquake risk assessments using Hazus for this Risk Report. The first assessment used a ShakeMap created for the M7.1 Border Ranges Scenario. The second assessment used a ShakeMap created for the M7.2 Intraplate Scenario. The third assessment used a ShakeMap created for the M7.5 Castle Mountain Scenario. The team completed all three earthquake risk assessments using local parcel data from the Municipality of Anchorage and the ShakeMaps as shown in Maps 3, 4, and 5.

For this study, the team incorporated individual parcel data from the Municipality of Anchorage into Hazus to allow losses to be reported at the parcel level. The team incorporated only properties with buildings (improvements) into the analysis; therefore, the team did not assess impacts to vacant land. Please refer to the appendix for a detailed methodology on incorporating local data into Hazus. The building loss from the earthquake assessments is summarized in Table 8 and displayed in Maps 6, 7, and 8.

Table 8: Hazus Earthquake Results for M7.1 and M9.2 Earthquakes in the Municipality of Anchorage

COMMUNITY NAME		TOTAL ESTIMATED VALUE (BUILDINGS AND CONTENTS IN DOLLARS)	TOTAL NUMBER OF BUILDINGS	BORDER RANGES M7.1 SCENARIO		INTRAPLATE M7.2 SCENARIO		CASTLE MOUNTAIN M7.5 SCENARIO	
				TOTAL DOLLAR LOSS	LOSS RATIO	TOTAL DOLLAR LOSS	LOSS RATIO	TOTAL DOLLAR LOSS	LOSS RATIO
Municipality of Anchorage	Anchorage	$57.5B	71,430	$616.5M	1.07%	$423.3M	0.74%	$336.5M	0.58%
	Chugiak	$1.7B	2,896	$86.1M	4.96%	$9.4M	0.54%	$15.0M	0.86%
	Eagle River	$4.4B	9,038	$222.4M	4.59%	$25.0M	0.52%	$23.8M	0.49%
	Girdwood	$513.7M	1,388	$424,586	0.08%	$510,324	0.10%	$169,483	0.03%
	Indian	$69.0M	130	$140,384	0.20%	$175,874	0.25%	$22,438	0.03%

COMMUNITY NAME	TOTAL ESTIMATED VALUE (BUILDINGS AND CONTENTS IN DOLLARS)	TOTAL NUMBER OF BUILDINGS	BORDER RANGES M7.1 SCENARIO		INTRAPLATE M7.2 SCENARIO		CASTLE MOUNTAIN M7.5 SCENARIO	
			TOTAL DOLLAR LOSS	LOSS RATIO	TOTAL DOLLAR LOSS	LOSS RATIO	TOTAL DOLLAR LOSS	LOSS RATIO
AK Bureau of Land Management	$417.4M	496	$3.9M	0.93%	$2.5M	0.59%	$1.4M	0.35%
Chugach State Park	$52.8M	16	$2.5M	4.67%	$378,359	0.72%	$670,307	1.27%
Chugach National Forest	$111.0M	16	$102,990	0.09%	$111,122	0.10%	$69,422	0.06%
Elmendorf Air Force Base	$281.3M	29	$8.0M	2.86%	$3.0M	1.08%	$2.6M	0.92%
Fort Richardson Military Reservation	$331.4M	25	$11.1M	3.36%	$3.8M	1.15%	$3.3M	0.99%
TOTAL	**$66.0M**	**85,464**	**$951.1M**	**1.44%**	**$468.2M**	**0.71%**	**$383.5M**	**0.58%**

Note: This table shows the total estimated parcel value by community. The total estimated value of improved parcels only includes parcels with buildings. The total estimated value of parcels is the total building and content value on that parcel. Content value was estimated based on a percentage of the building value, as defined in the Hazus model. Dollar losses are also reported as a loss ratio, which is calculated by the total losses (including building and contents loss)/total building and contents value. Estimated loss values are for the M7.1, M7.2, and M7.5 scenarios.

Building and content values in the Municipality of Anchorage total $65 billion and are highest in Anchorage ($57 billion). Eagle River ($4 billion) and Chugiak ($1 billion) have the second and third highest total building and content values.

Losses estimated from the M7.1 Border Ranges Scenario were high across all communities. The team estimated total building and content dollar loss at close to $951 million, with a municipality-wide loss ratio of 1.44 percent. The team projected that Chugiak (4.96 percent), Chugach State Park (4.67 percent), and Eagle River (4.59 percent) will have the highest loss ratios. The largest total loss values are projected for Anchorage ($616 million) and Eagle River ($222 million).

The impacts of the M7.2 Intraplate Scenario are less than those of the M7.1 Border Ranges Scenario. The team estimated total losses to be over $468 million, with a municipality-wide loss ratio of 0.71 percent. Loss ratios are highest for the Fort Richardson Military Reservation (3.36 percent) and Elmendorf Air Force Base (1.08 percent). Of the $468 million in projected losses, Anchorage had the largest losses at $423 million with a loss ratio of 0.74 percent. Eagle River has almost $24 million in total projected losses resulting in a loss ratio of 0.52 percent.

The M7.5 Castle Mountain Scenario resulted in loss estimates for all jurisdictions and communities within the Municipality of Anchorage. The team projected total losses for the Municipality of Anchorage from the M7.5 Castle Mountain Scenario to be $383 million with a loss ratio of 0.58 percent. The team projected that Anchorage would have the largest total estimated value of improved parcels, $336 million, resulting in a loss ratio of 0.58 percent. The team projected that Chugach State Park would have the highest loss ratio at 1.27 percent, with a total loss amount of $670,307.

Essential Facilities

The project team extracted essential facilities identified by the Municipality of Anchorage from the building analysis as shown in Table 9, Table 10Table 10, and Table 11 to determine the level of earthquake vulnerability after the identified earthquake event scenarios.

Table 9: Essential Facility Damage due to a M7.1 Border Ranges Scenario in the Municipality of Anchorage

ESSENTIAL FACILITY	TOTAL FACILITIES (HAZUS OUTPUT AVAILABLE)	TOTAL FACILITIES VALUE (BUILDING AND CONTENTS)	FACILITIES WITH 5% LOSS RATIO OR HIGHER	PERCENT FACILITIES WITH 5% LOSS RATIO OR HIGHER	TOTAL LOSS	LOSS RATIO
EOC	1	$68.7M	0	0.00%	$2.0M	2.85%
FIRE	19	$374.2M	4	21.05%	$6.3M	1.68%
HEALTH CARE	7	$2.2B	0	0.00%	$42.6M	1.98%
POLICE	2	$56.8M	1	50.00%	$1.6M	2.81%
SCHOOL	91	$3.9B	5	5.49%	$63.6M	1.64%
TOTAL	**120**	**$6.5B**	**10**	**8.33%**	**$116.0M**	**1.78%**

Table 10: Essential Facility Damage due to a M7.2 Intraplate Scenario in the Municipality of Anchorage

ESSENTIAL FACILITY	TOTAL FACILITIES (HAZUS OUTPUT AVAILABLE)	TOTAL FACILITIES VALUE (BUILDING AND CONTENTS)	FACILITIES WITH 5% LOSS RATIO OR HIGHER	PERCENT FACILITIES WITH 5% LOSS RATIO OR HIGHER	TOTAL LOSS	LOSS RATIO
EOC	1	$68.7M	0	0.00%	$1.4M	2.04%
FIRE	19	$374.2M	0	0.00%	$3.7M	0.98%
HEALTH CARE	7	$2.2B	0	0.00%	$20.1M	0.94%
POLICE	2	$56.8M	0	0.00%	$783,571	1.38%
SCHOOL	91	$3.9B	0	0.00%	$31.9M	0.82%
TOTAL	**120**	**$6.5B**	**0**	**0.00%**	**$57.8M**	**0.89%**

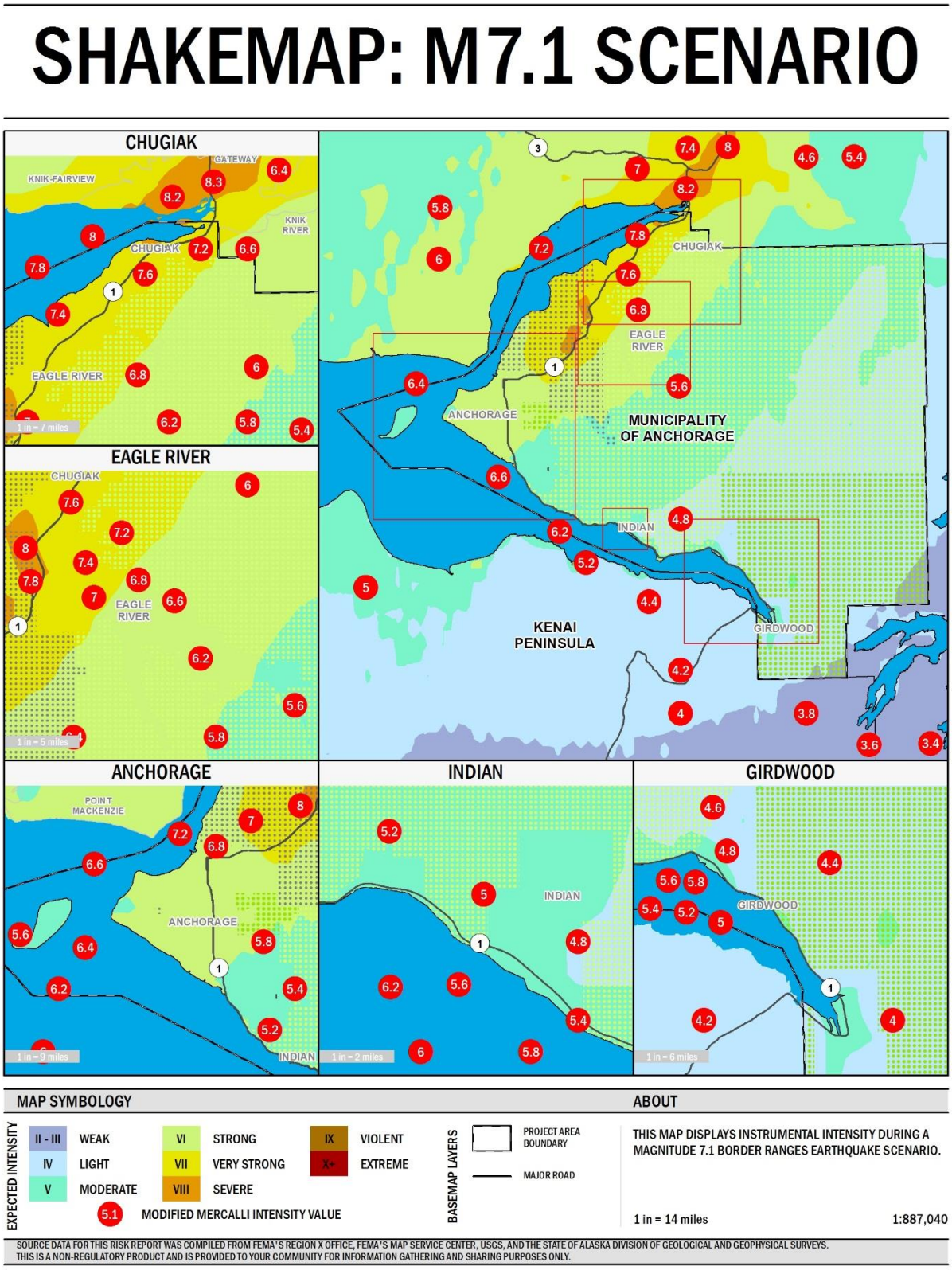
Table 11: Essential Facility Damage due to a M7.5 Castle Mountain Scenario in the Municipality of Anchorage

ESSENTIAL FACILITY	TOTAL FACILITIES (HAZUS OUTPUT AVAILABLE)	TOTAL FACILITIES VALUE (BUILDING AND CONTENTS)	FACILITIES WITH 5% LOSS RATIO OR HIGHER	PERCENT FACILITIES WITH 5% LOSS RATIO OR HIGHER	TOTAL LOSS	LOSS RATIO
EOC	1	$68.7M	0	0.00%	$1.4M	2.10%
FIRE	19	$374.2M	0	0.00%	$3.4M	0.90%
HEALTH CARE	7	$2.2B	0	0.00%	$20.4M	0.95%
POLICE	2	$56.8M	0	0.00%	$703,196	1.24%
SCHOOL	91	$3.9B	0	0.00%	$24.4M	0.63%
TOTAL	**120**	**$6.5B**	**0**	**0.00%**	**$50.3M**	**0.77%**

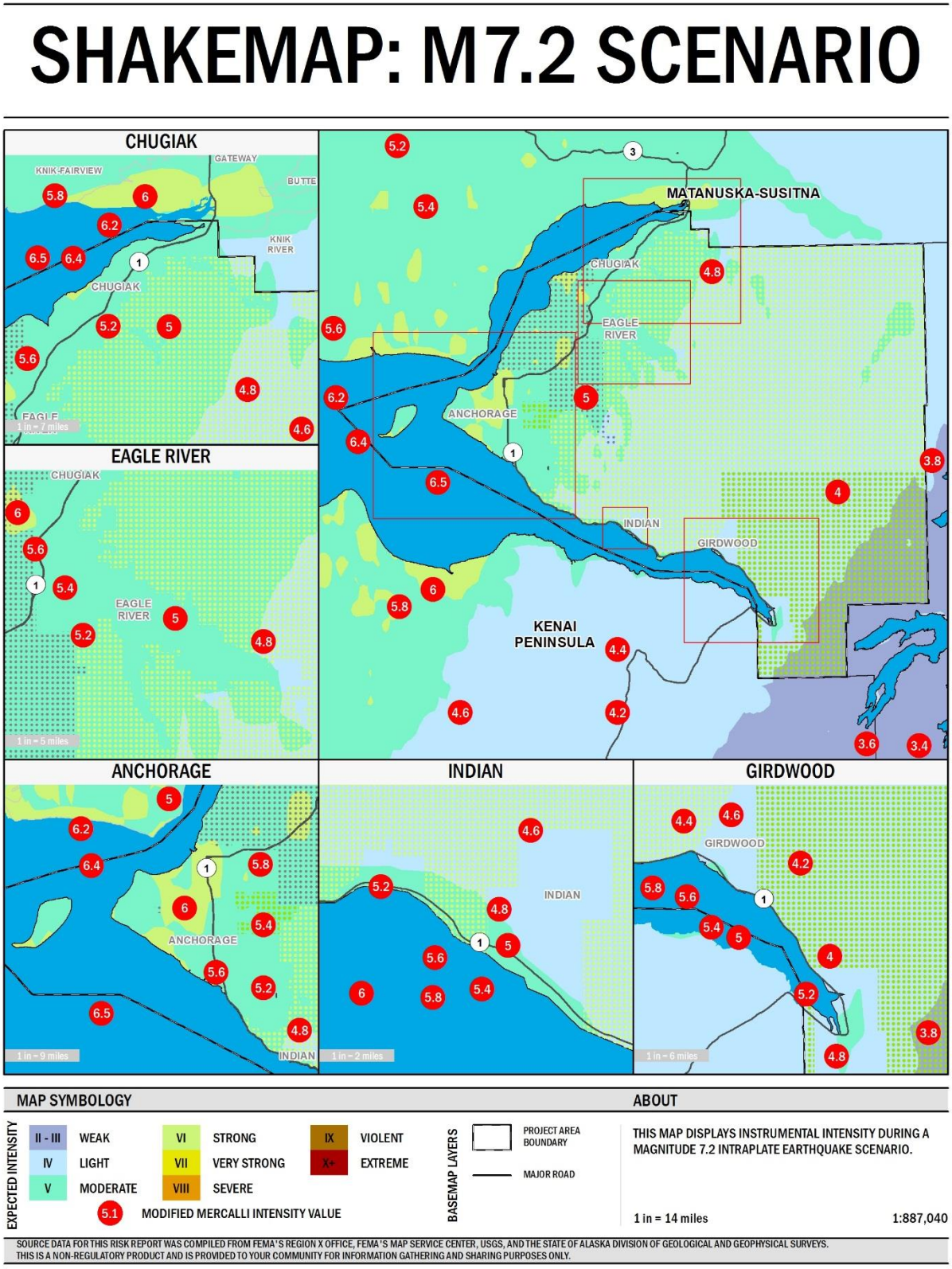
The total estimated facilities value is the total building and content value on that parcel divided equally by the number of facilities on an improved parcel. Content value was estimated based on a percentage of the building value, as defined in the Hazus model. Dollar losses are reported as is a loss ratio, which is calculated as the total losses (including building and contents loss)/total building and contents value.

Of the essential facilities with a Hazus earthquake output, the project team found that the M7.1 Border Ranges Scenario has the highest total loss at $115 million (also displayed in Map 9). This would account for nearly 1.78 percent of defined facilities within the Municipality of Anchorage. For all three scenarios, no Emergency Operation Centers would experience a loss ratio of 5 percent or higher, allowing emergency services to be maintained and monitored during an estimated earthquake scenario. For the M7.1 Border Ranges Scenario, the team estimated that 10 facilities with a 5 percent or higher loss ratio. The facilities are schools (five buildings), fire (four buildings), and police (one building). The team projected that schools would have the highest total loss values of all defined facilities. A detailed breakout of facilities is provided in the Areas of Mitigation Interest tables in Section 13 of this Risk Report. Additional information is also available in the Risk Database included with this Risk Report.

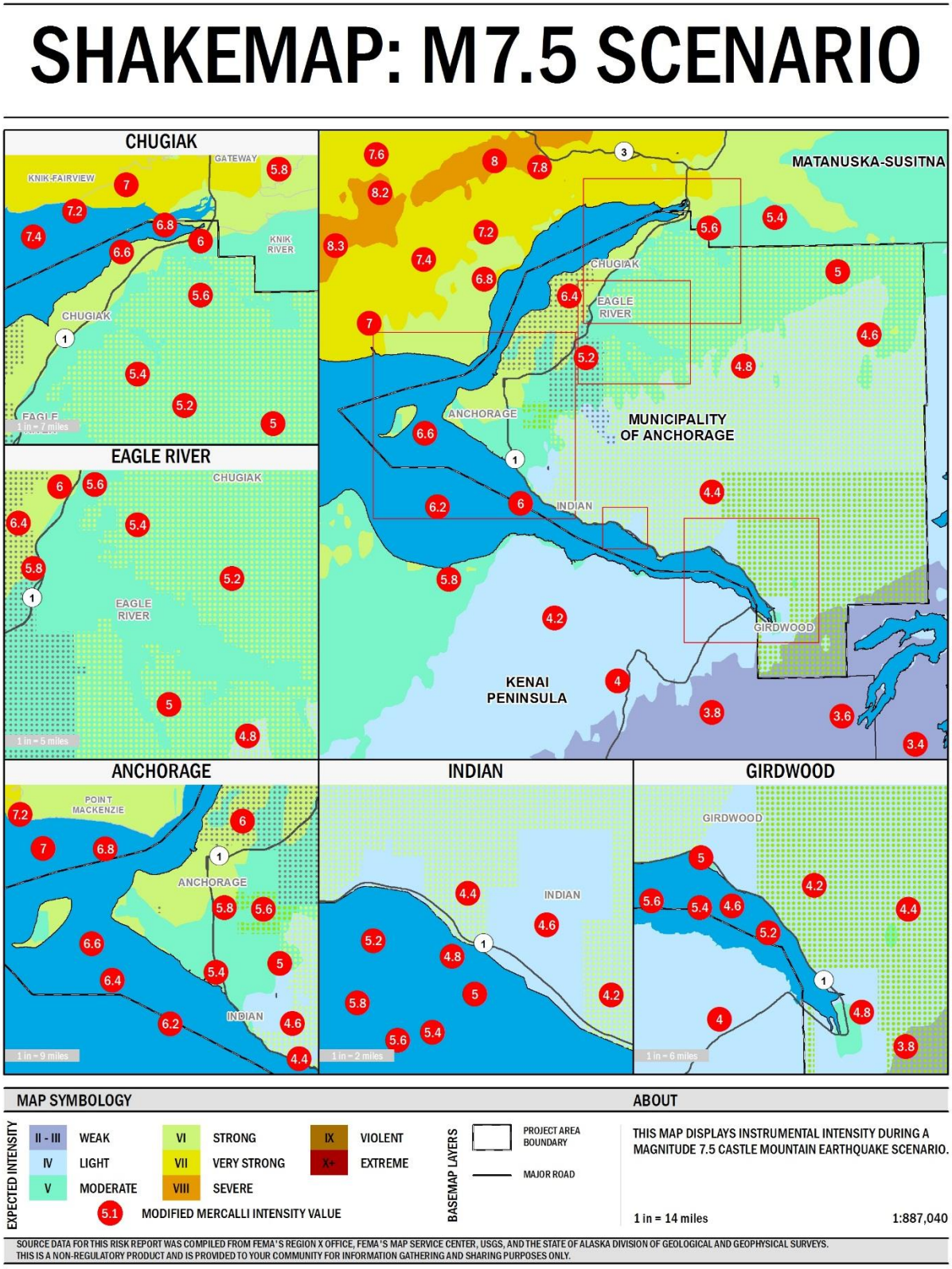
Map 3: ShakeMap of M7.1 Border Ranges Scenario



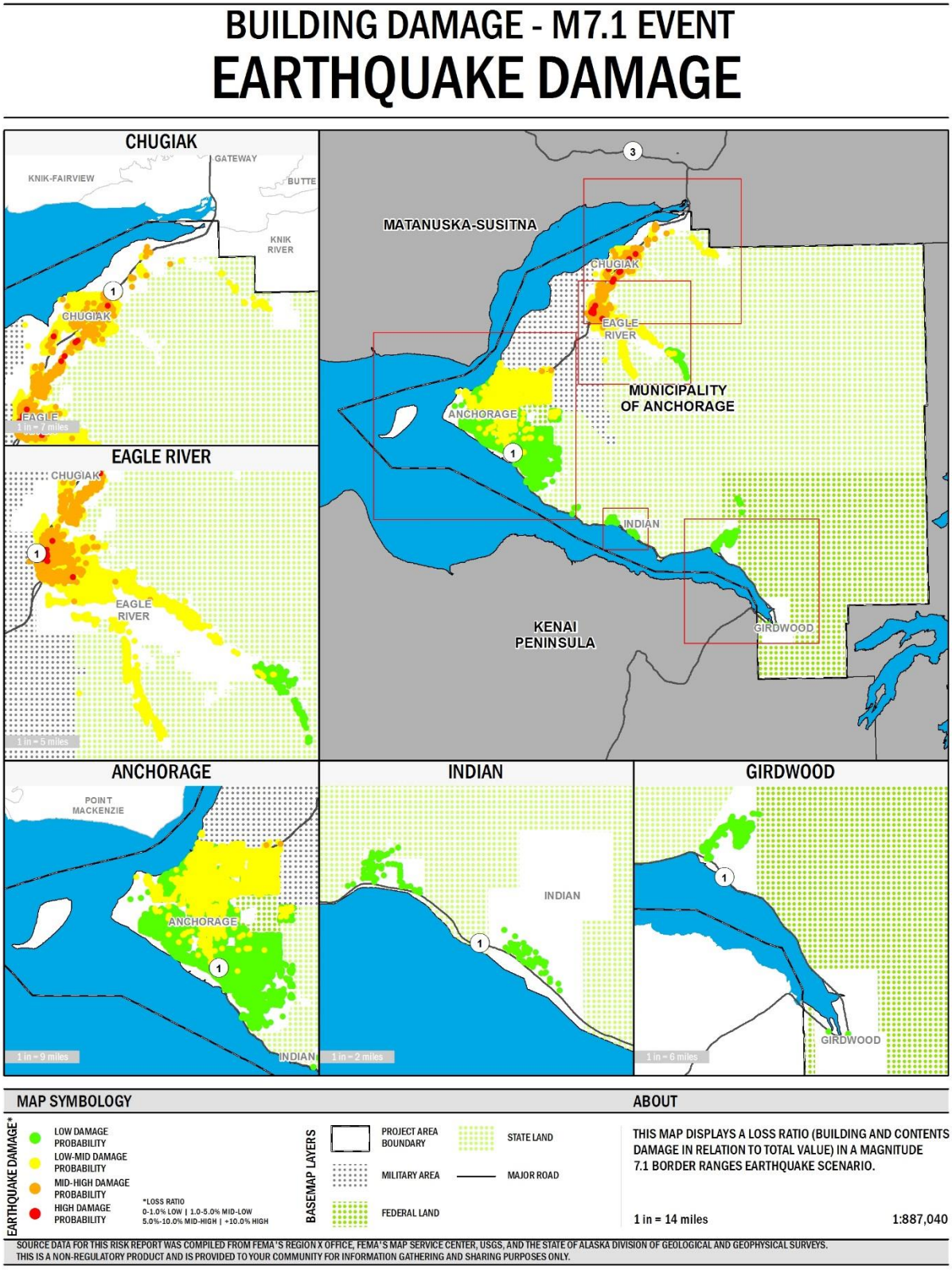
Map 4: ShakeMap of a M7.2 Intraplate Scenario



Map 5: ShakeMap of a M7.5 Castle Mountain Scenario

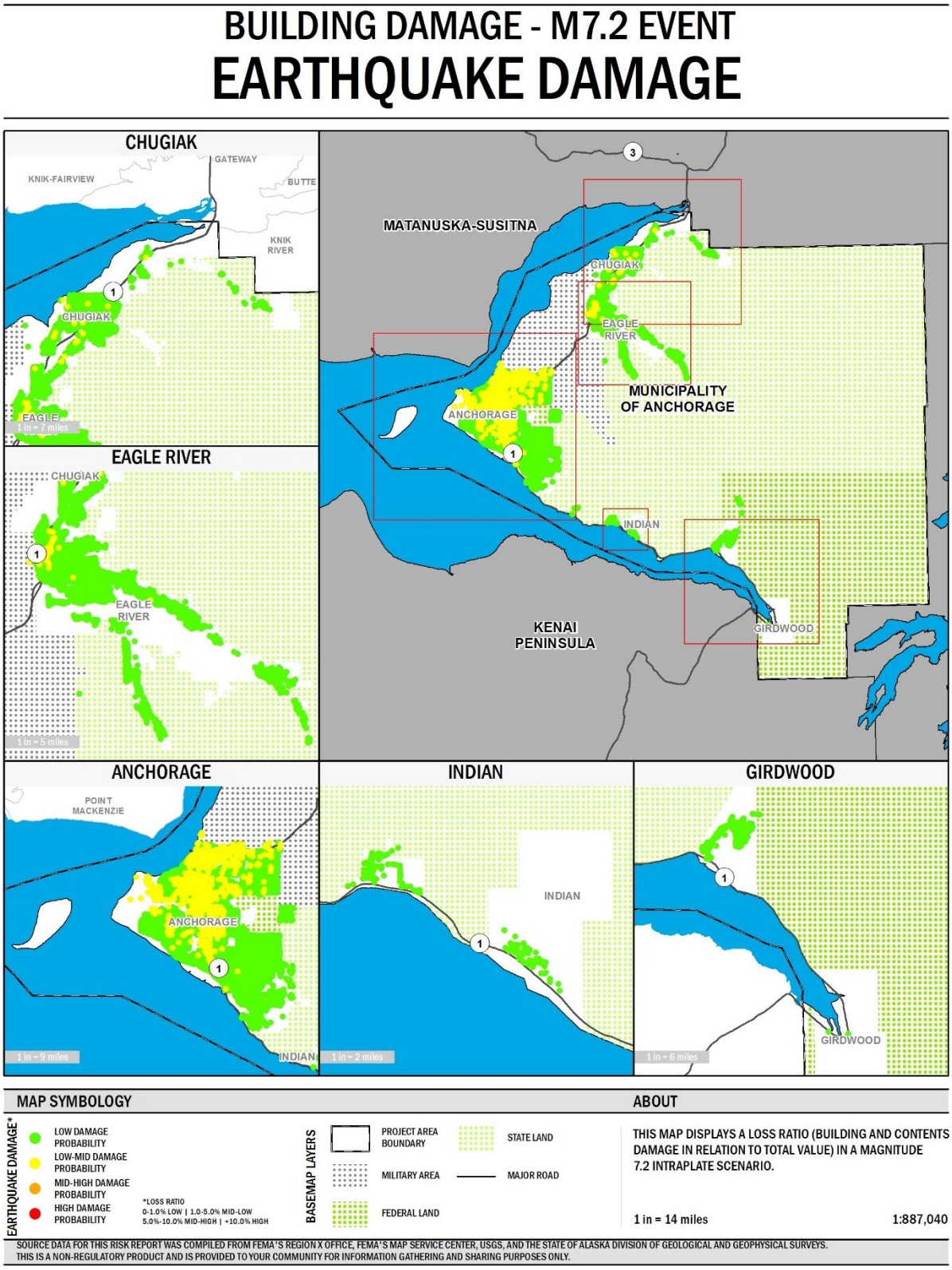


Map 6: M7.1 Border Ranges Scenario - Damage Referenced as Loss Ratio in the Municipality of Anchorage



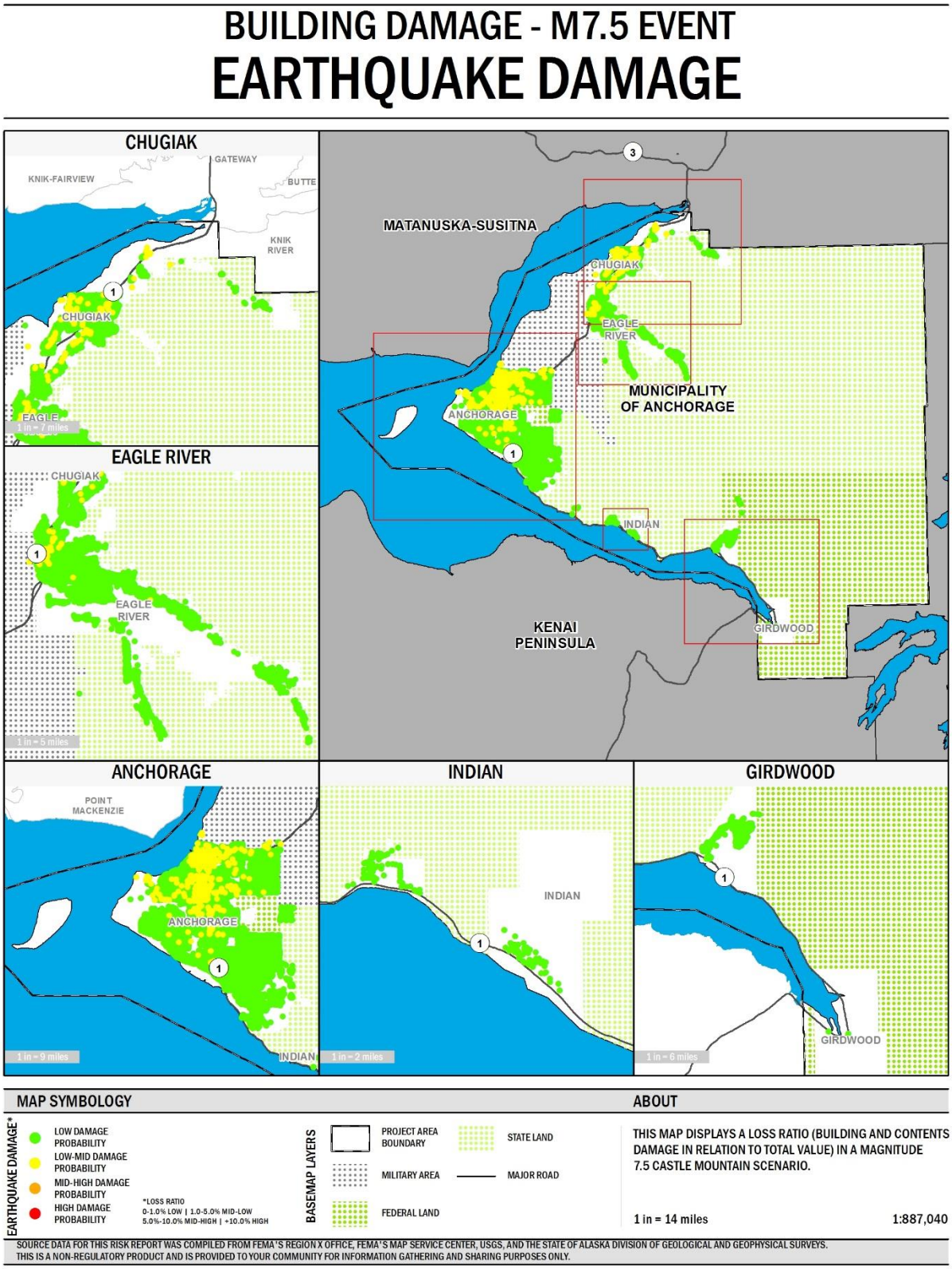
**Damage does not factor collateral effects like landslides, land subsidence, liquefaction, fire, flooding, or tsunami.*

Map 7: M7.2 Intraplate Scenario – Damage Referenced as Loss Ratio in the Municipality of Anchorage*



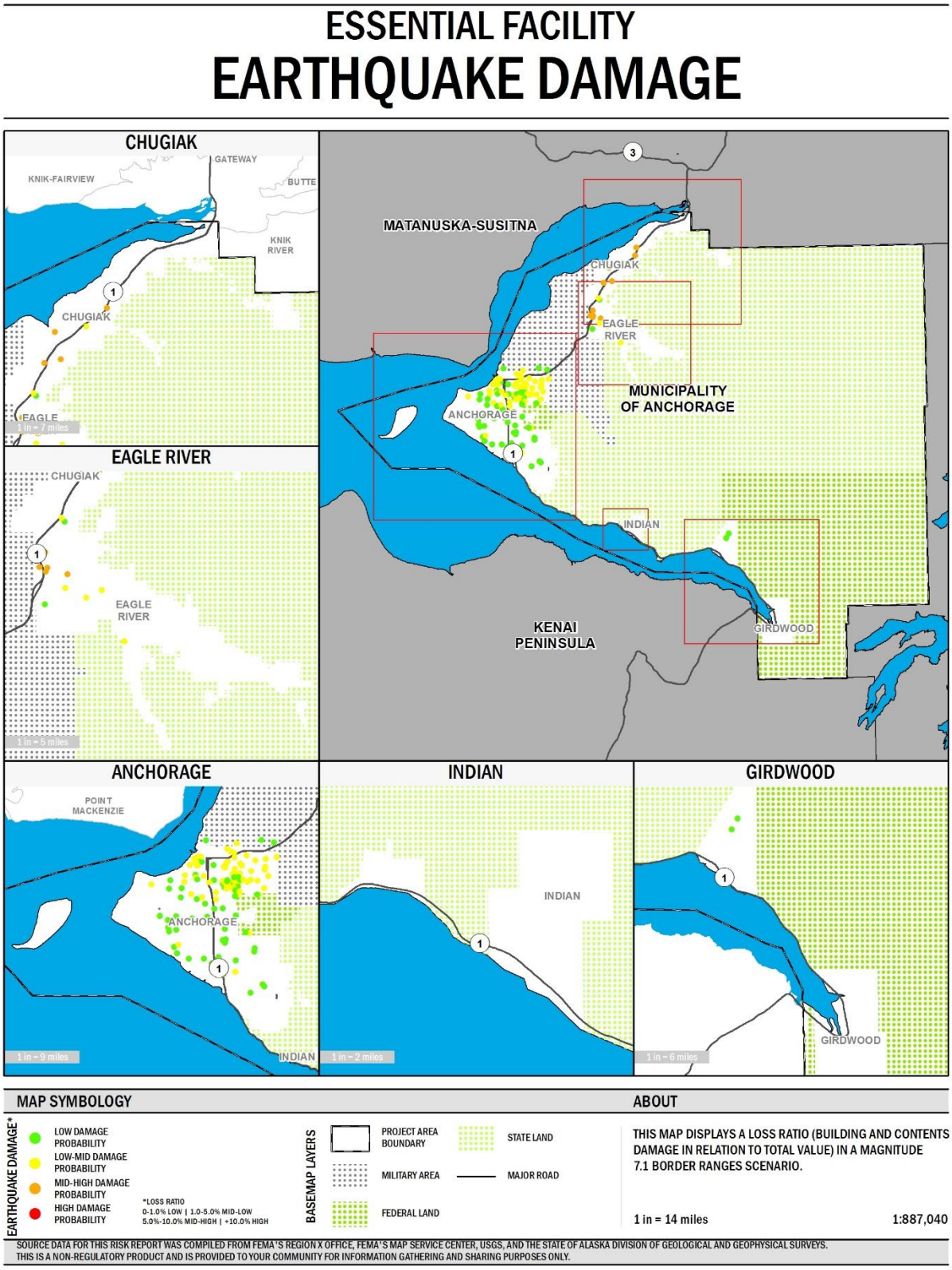
**Damage does not factor collateral effects like landslides, land subsidence, liquefaction, fire, flooding, or tsunami.*

Map 8: M7.5 Castle Mountain Scenario – Damage Referenced as Loss Ratio in the Municipality of Anchorage*



**Damage does not factor collateral effects like landslides, land subsidence, liquefaction, fire, flooding, or tsunami.*

Map 9: M7.1 Border Ranges Scenario – Damage Referenced as Loss Ratio in the Municipality of Anchorage to Essential Facilities*



**Damage does not factor collateral effects like landslides, land subsidence, liquefaction, fire, flooding, or tsunami.*

Transportation and Utility Assessment

Hazus also provided an analysis on transportation and utility systems. Transportation systems include highways, railways, light rail, buses, ports, ferries, and airports. Utility systems include potable water, wastewater, natural gas, crude and refined oil, electric power, and communication. The project team took the transportation and utility information from the original Hazus database. *No local updates were applied, so the number of facilities could vary greatly from what actually exists.* Table 12 provides an overview of potential damage to transportation systems in the event of an M7.1 earthquake, summarized at the Municipality level.

Table 12: Transportation System Impacts for M7.1 Border Ranges Scenario in the Municipality of Anchorage

TRANSPORTATION SYSTEM	COMPONENT	LOCATIONS/ SEGMENTS	MODERATE DAMAGE OR GREATER	FUNCTIONALITY		INVENTORY VALUE	ECONOMIC LOSS	LOSS RATIO
				After Day 1	After Day 7			
Highway	Segments	23	0	23	23	$476.5M	---	---
	Bridges	99	21	86	90	$2.5B	$207.5M	8.43%
	Tunnels	2	0	2	2	$58.1M	---	---
Railway	Segments	282	0	282	282	$181.2M	---	---
	Bridges	4	0	4	4	$1.1M	---	---
	Facilities	11	0	11	11	$29.5M	$6.7M	22.68%
Light Rail	Segments	0	0	0	0	---	---	---
	Facilities	0	0	0	0	---	---	---
	Facilities	0	0	0	0	---	---	---
Bus	Facilities	1	0	1	1	$1.3M	$300,000	23.08%
Ferry	Facilities	0	0	0	0	---	---	---
Port	Facilities	8	0	8	8	$21.5M	$4.9M	22.60%
Airport	Runways	19	0	19	19	$726.3M	---	---
	Facilities	14	2	13	14	$93.8M	$19.8M	21.11%
TOTAL		**463**	**23**	**449**	**4**	**$4.1B**	**$239.1M**	**5.91%**

Table 13 provides an overview of potential damage to transportation systems in the event of an M7.2 earthquake. Table 14 identifies potential transportation losses related to an M7.5 earthquake. Table 15 provides an overview of the utility systems in the event of an M7.1 earthquake. Table 16 and Table 17 provide overviews of the utility systems in the event of an M7.2 earthquake and M7.5 earthquake, respectively. Tables 13 through 17 also are summarized at the Municipality level.

Table 13: Transportation System Impacts for M7.2 Intraplate Scenario in the Municipality of Anchorage

TRANSPORTATION SYSTEM	COMPONENT	LOCATIONS / SEGMENTS	MODERATE DAMAGE OR GREATER	FUNCTIONALITY		INVENTORY VALUE	ECONOMIC LOSS	LOSS RATIO
				After Day 1	After Day 7			
Highway	Segments	23	0	23	23	$476.5M	---	---
	Bridges	99	0	99	99	$2.5B	$25.6M	1.04%
	Tunnels	2	0	2	2	$58.1M	---	---
Railway	Segments	282	0	282	282	$181.2M	---	---
	Bridges	4	0	4	4	$1.1M	---	---
	Facilities	11	0	11	11	$29.5M	$5.5M	18.61%
Light Rail	Segments	0	0	0	0	---	---	---
	Facilities	0	0	0	0	---	---	---
	Facilities	0	0	0	0	---	---	---
Bus	Facilities	1	0	1	1	$1.3M	$250,000	19.23%
Ferry	Facilities	0	0	0	0	---	---	---
Port	Facilities	8	0	8	8	$21.5M	$4.0M	18.60%
Airport	Runways	19	0	19	19	$726.3M	---	---
	Facilities	14	0	14	14	$93.8M	$15.0M	15.97%
TOTAL		**463**	**0**	**463**	**463**	**$4.1B**	**$50.3M**	**1.24%**

Table 14: Transportation System Impacts for M7.5 Castle Mountain Scenario in the Municipality of Anchorage

TRANSPORTATION SYSTEM	COMPONENT	LOCATIONS / SEGMENTS	MODERATE DAMAGE OR GREATER	FUNCTIONALITY		INVENTORY VALUE	ECONOMIC LOSS	LOSS RATIO
				After Day 1	After Day 7			
Highway	Segments	23	0	23	23	$476.5M	---	---
	Bridges	99	0	99	99	$2.5B	$43.0M	1.75%
	Tunnels	2	0	2	2	$58.1M	---	---
Railway	Segments	282	0	282	282	$181.2M	---	---
	Bridges	4	0	4	4	$1.1M	---	---
	Facilities	11	0	11	11	$29.5M	$5.1M	17.40%
Light Rail	Segments	0	0	0	0	---	---	---
	Facilities	0	0	0	0	---	---	---
	Facilities	0	0	0	0	---	---	---

TRANSPORTATION SYSTEM	COMPONENT	LOCATIONS / SEGMENTS	MODERATE DAMAGE OR GREATER	FUNCTIONALITY		INVENTORY VALUE	ECONOMIC LOSS	LOSS RATIO
				After Day 1	After Day 7			
Bus	Facilities	1	0	1	1	$1.3M	$250,000	18.66%
Ferry	Facilities	0	0	0	0	---	---	---
Port	Facilities	8	0	8	8	$21.5M	$4.0M	18.66%
Airport	Runways	19	0	19	19	$726.3M	---	---
	Facilities	14	0	14	14	$93.8M	$12.7M	13.55%
TOTAL		**463**	**0**	**463**	**463**	**$4.1B**	**$65.0M**	**1.61%**

Minimal economic losses for transportation systems are projected for the M7.1 Border Ranges Scenario. However, the degrees of economic loss to these systems under the M7.2 Intraplate and M7.5 Castle Mountain Scenarios vary. Highway bridges and port and airport facilities are at the greatest risk. Port and airport facilities have estimated loss ratios that average 18.4 percent and are 100 percent functional after Day 1. In total dollars, highway bridges are the most affected. Over $42 million would be lost during the M7.5 Border Ranges Scenario. Collectively, transportation systems are estimated to lose more than $1 billion, which represents an average loss ratio of 1.42 percent.

Table 15: Utility System Impacts for M7.1 Border Ranges Scenario in the Municipality of Anchorage

UTILITY SYSTEM	COMPONENT	FACILITIES / SEGMENTS (KM)	MODERATE DAMAGE OR GREATER	FUNCTIONALITY		INVENTORY VALUE	ECONOMIC LOSS	LOSS RATIO
				After Day 1	After Day 7			
Potable Water	Facilities	0	0	0	0	---	---	---
	Pipelines	10,700	0	0	0	$214.0M	---	---
Waste Water	Facilities	4	0	0	0	$327.7M	---	---
	Pipelines	6,420	0	0	0	$128.4M	---	---
Oil Systems	Facilities	1	0	0	0	$100,000	---	---
	Pipelines	NA	0	0	0	---	---	---
Natural Gas	Facilities	0	0	0	0	---	---	---
	Pipelines	4,280	0	0	0	$85.6M	---	---
Electric Power	Facilities	5	0	0	0	$676.5M	---	---
Communication	Facilities	34	0	0	0	$4.2M	---	---
TOTAL		**44 / 21,400**	**0**	**0**	**0**	**$1.4B**	---	---

Table 16: Utility System Impacts for M7.2 Intraplate Scenario in the Municipality of Anchorage

UTILITY SYSTEM	COMPONENT	FACILITIES / SEGMENTS (KM)	MODERATE DAMAGE OR GREATER	FUNCTIONALITY		INVENTORY VALUE	ECONOMIC LOSS	LOSS RATIO
				After Day 1	After Day 7			
Potable Water	Facilities	0	0	0	0	---	---	---
	Pipelines	10,700	0	0	0	$214.0M	---	---
Waste Water	Facilities	4	0	0	0	$327.7M	---	---
	Pipelines	6,420	0	0	0	$128.4M	---	---

UTILITY SYSTEM	COMPONENT	FACILITIES / SEGMENTS (KM)	MODERATE DAMAGE OR GREATER	FUNCTIONALITY		INVENTORY VALUE	ECONOMIC LOSS	LOSS RATIO
				After Day 1	After Day 7			
Oil Systems	Facilities	1	0	0	0	$100,000	---	---
	Pipelines	NA	0	0	0	---	---	---
Natural Gas	Facilities	0	0	0	0	---	---	---
	Pipelines	4,280	0	0	0	$85.6M	---	---
Electric Power	Facilities	5	0	0	0	$676.5M	---	---
Communication	Facilities	34	0	0	0	$4.2M	---	---
TOTAL		**44 / 21,400**	**0**	**0**	**0**	**$1.4B**	---	---

Table 17: Utility System Impacts for M7.5 Castle Mountain Scenario in the Municipality of Anchorage

UTILITY SYSTEM	COMPONENT	FACILITIES / SEGMENTS (KM)	MODERATE DAMAGE OR GREATER	FUNCTIONALITY		INVENTORY VALUE	ECONOMIC LOSS	LOSS RATIO
				After Day 1	After Day 7			
Potable Water	Facilities	0	0	0	0	---	---	---
	Pipelines	10,700	0	0	0	$214.0M	---	---
Waste Water	Facilities	4	0	0	0	$327.7M	---	---
	Pipelines	6,420	0	0	0	$128.4M	---	---
Oil Systems	Facilities	1	0	0	0	$100,000	---	---
	Pipelines	NA	0	0	0	---	---	---
Natural Gas	Facilities	0	0	0	0	---	---	---
	Pipelines	4,280	0	0	0	$85.6M	---	---
Electric Power	Facilities	5	0	0	0	$676.5M	---	---
Communication	Facilities	34	0	0	0	$4.2M	---	---
TOTAL		**44 / 21,400**	**0**	**0**	**0**	**$1.4B**	---	---

The utility system loss estimation capabilities require a great deal of user input and modification to model the inventory, which was beyond the scope of this Risk Report.

Building Code Analysis

The Center for Climate and Energy Solutions (C2ES) Report from the March 2016 Disaster Resilience Workshop documented a lack of city codes that encourage building resilience. The loss data from Hazus and the design code analysis highlight the buildings and areas potentially affected by earthquakes. Local officials can use these data for building code considerations, for identification of properties for mitigation projects, and areas to target for additional outreach. The highlighted areas of greatest impacts and potential mitigation actions, based on the above Hazus analysis, are discussed in the community-specific section of this Risk Report (Section 13, Areas of Mitigation Interest).

By performing an additional analysis, the project team identified many buildings were constructed to a specific building code. Hazus identifies key changes in earthquake building codes, based on year. Homes built before 1941 that are not constructed with a wood frame are considered pre-code; they were constructed before earthquake building codes were put in place. Homes constructed after 1941 or built

prior to 1941 but with a wood frame are considered moderate code and may include some earthquake-resistant building components. Buildings built after 1975 are considered high code. The dates for local building codes may be slightly different from the dates shown below; however, local officials can use the information as a general planning tool until more information on the local building code can be acquired. The results of each code type are summarized in Table 18.

Table 18: Pre-Code and Moderate Code Buildings in the Municipality of Anchorage

COMMUNITY NAME		TOTAL NUMBER OF BUILDINGS	TOTAL PRE-CODE BUILDINGS	PERCENT PRE-CODE BUILDINGS	TOTAL MODERATE-CODE BUILDINGS	PERCENT MODERATE-CODE BUILDINGS	TOTAL HIGH-CODE BUILDINGS	PERCENT HIGH-CODE BUILDINGS
Municipality of Anchorage	Anchorage	71,430	2	0.00%	20,607	28.85%	50,821	71.15%
	Chugiak	2,896	0	0.00%	448	15.47%	2,448	84.53%
	Eagle River	9,038	0	0.00%	909	10.06%	8,129	89.94%
	Girdwood	1,388	0	0.00%	298	21.47%	1,090	78.53%
	Indian	130	0	0.00%	24	18.46%	106	81.54%
AK Bureau of Land Management		496	0	0.00%	58	11.69%	438	88.31%
Chugach State Park		16	0	0.00%	1	6.25%	15	93.75%
Chugach National Forest		16	0	0.00%	2	12.50%	14	87.50%
Elmendorf Air Force Base		29	0	0.00%	1	3.45%	28	96.55%
Fort Richardson Military Reservation		25	0	0.00%	7	28.00%	18	72.00%
TOTAL		**85,464**	**2**	**0.00%**	**22,355**	**26.16%**	**63,107**	**73.84%**

High loss ratios in earthquake events are typically attributed to the number of pre-code structures in each community. Because of their age and pre-code status, these buildings would not perform as well in an earthquake. Contrarily, high-code buildings will fare much better in the event of an earthquake. The Municipality of Anchorage has two pre-code buildings (built before 1941, without a wood frame), and just over 26 percent of all facilities are moderate code. The remaining almost 74 percent were built to meet high code specifications. The areas with the highest percentage of moderate-code buildings are Anchorage (28.85 percent), Fort Richardson Military Reservation (28 percent), and Girdwood (24.47 percent). Anchorage (20,607) has the largest number of moderate-code buildings. Areas with the highest percentage of high-code buildings include Elmendorf Air Force Base (96.5 percent), Chugach State Park (93.7 percent), and Eagle River (89.9 percent). By volume, the community with the most high-code buildings is Anchorage with 50,821.

7. Avalanche Exposure Assessment

Avalanche Hazard Overview

The 2011 FEMA Risk MAP Discovery effort and 2011 Anchorage All Hazards Mitigation Plan identified avalanches as a primary concern. Within the Municipality of Anchorage, there are two main types of snow avalanches: loose snow and slab. Other types of avalanches include cornice collapse, ice, and slush. Loose snow avalanches typically occur on slopes above 35 degrees and leave behind an inverted V-shaped scar. They are often caused by snow overloading (common during or just after a snowstorm), vibration, or warming (triggered by rain, rising temperatures, or solar radiation). Slab avalanches are the most dangerous types of avalanches and happen when a mass of cohesive snow breaks away and travels down the mountainside. As it moves, the slab breaks up into smaller cohesive blocks.

Although avalanches occur every year within the Municipality of Anchorage, the most remembered avalanches in recent history are those associated with the 2002 winter storms. Those avalanches resulted in serious damage throughout the Municipality. These avalanche events were declared Federal disasters.

Table 19: Presidentially Declared Avalanche Disaster History for the Municipality of Anchorage

DISASTER NUMBER	DECLARATION DATE	DISASTER TYPE	INCIDENT TYPE	TITLE	INCIDENT BEGIN DATE	INCIDENT END DATE
1316	2/17/2000	DR	Winter Storms and Avalanches	WINTER STORMS AND AVALANCHES	12/21/1999	2/23/2000

DR-1316

From December 21, 1999, to February 23, 2000, severe winter storms triggered avalanches within the Municipality of Anchorage. News articles reported on many missing individuals and fatalities as a result of this series of avalanches. Federal disaster aid was made available on February 17, 2000, as a result of a presidential disaster declaration. The declaration covered damage to both public and private property in the Municipality of Anchorage and throughout other areas of Alaska that were impacted by these events. In addition to public and private funding, just over $2 million was made available statewide through the FEMA Hazard Mitigation Grant Program (HMGP), however, no funds were specifically allocated to the Municipality of Anchorage.

Table 20: DR-1316 Public Assistance - Dollars Approved

	TOTAL PUBLIC ASSISTANCE GRANTS - DOLLARS OBLIGATED*	EMERGENCY WORK (CATEGORIES A-B) - DOLLARS OBLIGATED*	PERMANENT WORK (CATEGORIES C-G) - DOLLARS OBLIGATED*
Total Amount	$10,798,817.35	$6,382,892.52	$4,291,133.67

Avalanche Exposure Assessment Overview

Avalanches occur within the Municipality of Anchorage every year, but typically occur in more remote areas. Avalanches can occur anywhere, but gullies, steep snow-covered slopes, and areas below steep ridges are particularly susceptible. To identify avalanche-prone areas in Anchorage, Arthur Mears conducted the Anchorage Snow Avalanche Zoning Analysis in 1982 (full report in Appendix B). The area with the potential for the largest avalanches is the Girdwood/Crow Creek area. Evidence of snow avalanches is prominent along the mountainsides above the Girdwood Valley. The western mountainside has high and moderate avalanche danger from Turnagain Arm to California Creek. Avalanche hazard is

moderate to high on the eastern mountainside at the head of the valley, near the day lodge and resort area, and southeast of Virgin Creek. Other areas south of the Anchorage Bowl that may experience avalanches are Bird Creek, Indian, and Rainbow. North of the Anchorage Bowl, the areas near the South Fork of the Eagle River, Eagle River, Peters Creek (especially near what is locally known as 4-mile), and Mirror Lake/N.W. Spur of Mount Eklutna have avalanche potential. Another avalanche-prone area is the Seward Highway between the flats near Bird Point and the entrance to the Girdwood Valley (Map 10). The results of this exposure assessment, which identified various locations within the Municipality of Anchorage as at risk of avalanche occurrences, are summarized in Table 21.

Table 21: Parcel Improvement Exposure Associated with Avalanche in the Municipality of Anchorage

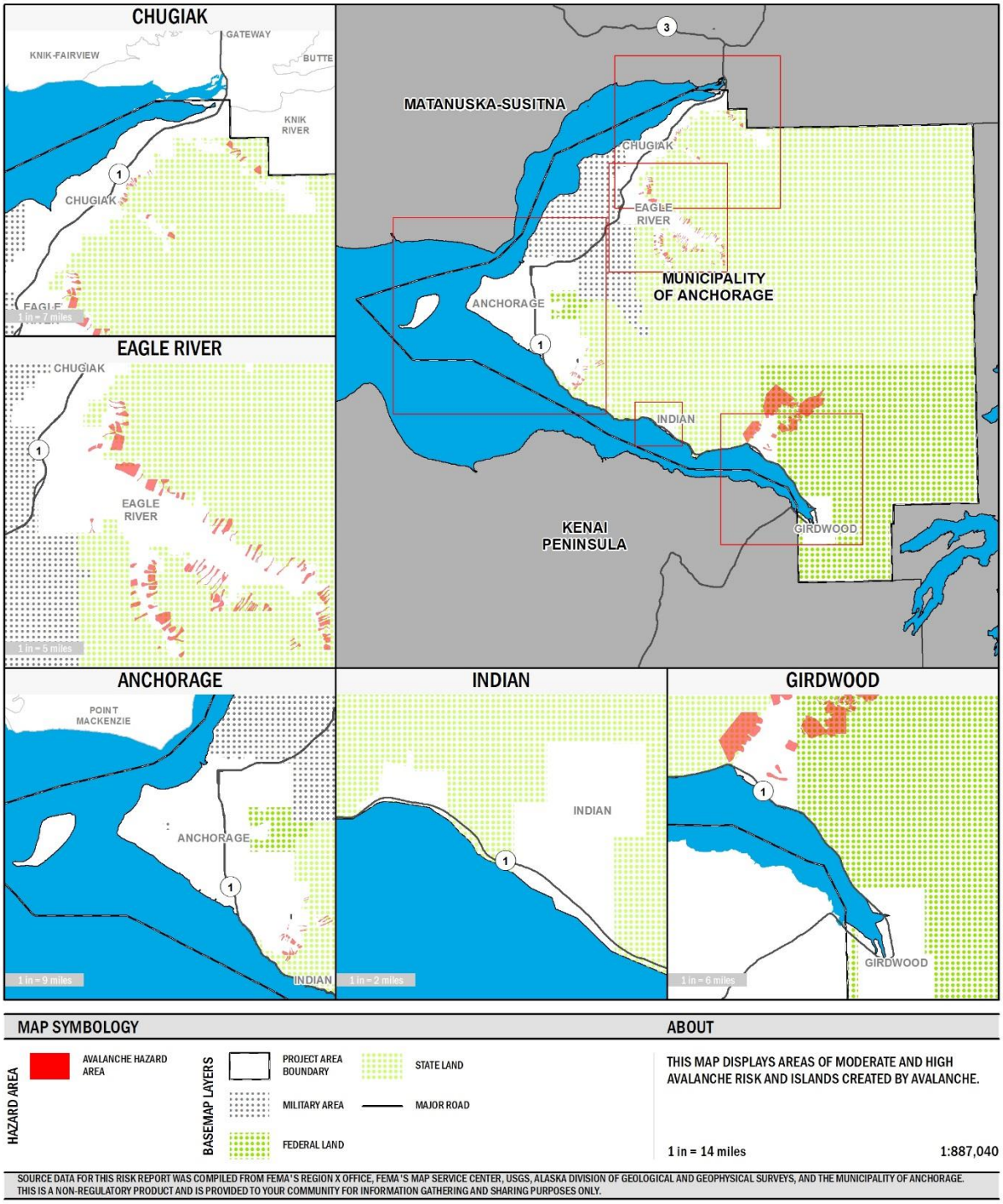
COMMUNITY NAME		TOTAL NUMBER OF BUILDINGS	BUILDINGS IN AVALANCHE HAZARD AREA	PERCENT BUILDINGS IN AVALANCHE HAZARD AREA	TOTAL ESTIMATED VALUE (BUILDINGS AND CONTENTS)	BUILDING VALUE EXPOSURE IN AVALANCHE HAZARD AREA	PERCENT BUILDING VALUE EXPOSURE IN AVALANCHE HAZARD AREA
Municipality of Anchorage	Anchorage	71,430	4	0.04%	$57.5B	$2.1M	0.00%
	Chugiak	2,896	5	0.05%	$417.4M	$2.3M	0.54%
	Eagle River	9,038	111	1.11%	$4.8B	$56.2M	1.16%
	Girdwood	1,388	75	0.75%	$513.7M	$59.0M	11.49%
	Indian	130	---	---	$69.0M	---	0.00%
AK Bureau of Land Management		496	---	---	$417.4M	---	---
Chugach State Park		16	4	25.00%	$52.8M	$534,208	1.01%
Chugach National Forest		16	10	62.50%	$111.0M	$4.7M	4.25%
Elmendorf Air Force Base		29	---	---	$281.3M	---	---
Fort Richardson Military Reservation		25	---	---	$331.4	---	---
TOTAL		**85,464**	**206**	**2.06%**	**$64.6B**	**$125.0M**	**0.19%**

In the Municipality of Anchorage, 206 structures are vulnerable to avalanche hazards. Most of the avalanche risk areas are west of Anchorage. Eagle River and Girdwood have the largest number of structures within avalanche hazard areas. Eagle River has 111 structures within avalanche hazard areas, and Girdwood has 75 structures within avalanche hazard areas. Girdwood does not have the highest amount of structures within the avalanche hazard area, but the community does have the highest estimated building value exposure. In total, 2.06 percent of structures in the Municipality of Anchorage are vulnerable to potential avalanche hazard occurrences, which places over $124 million dollars in building value at risk.

Local officials can use the avalanche analysis to consider areas where an avalanche ordinance could be adopted, to identify individual properties for mitigation projects, and areas for targeted outreach. Areas of greatest impact and potential mitigation actions are discussed in Section 13, Areas of Mitigation Interest. All results, databases, and maps are provided in the Risk Assessment Database included with this Risk Report.

Map 10: Avalanche Risk in the Municipality of Anchorage

AVALANCHE



8. Dam Failure Exposure Assessment

Dam Hazard Overview

Presidentially declared disasters across the United States related to dam failure date back to 1963. The most recent of these dam failures occurred in 1982. The Lawn Lake Dam, an earthen dam in the Colorado Rocky Mountain National Park, failed and released 30 million cubic feet of water. The flash flood resulted in the death of three campers and caused $31 million worth of damage in communities downstream. In 1977, the Kelly Barnes Dam in Georgia failed, killing 39 people and causing $2.8 million in damage. The earthen dam could not withstand the prolonged period of heavy rainfall and collapsed. A catastrophic dam failure occurred in 1976 in Idaho on the Teton River. Just after the earthen dam was constructed, upon filling the reservoir for the first time, the dam collapsed. The failure resulted in the deaths of 11 people and over 10,000 cattle, costing an estimated $2 billion in damage; $300 million in Federal aid was paid out in damage-related claims. That dam has not been rebuilt. In 1973, the small farming town of Kersey, Colorado, was inundated following the failure of the Latham Reservoir Dam. Floodwaters damaged nearly all the homes in Kersey and a newly renovated school. Fortunately, warning was provided in advance, and the residents were evacuated. The first presidentially declared disaster related to dam failure occurred in 1963. The Baldwin Hills Dam in Baldwin Hills, California, failed and released 250 million gallons of water, flooding the nearby residential communities. The flood resulted in five deaths and damaged 277 homes.

Table 22: Presidentially Declared Dam Failure Disaster History for the United States

DISASTER NUMBER	DECLARATION DATE	STATE	COUNTY	INCIDENT TYPE	TITLE	INCIDENT BEGIN/END DATE	TOTAL PUBLIC ASSISTANCE GRANTS - DOLLARS OBLIGATED*
DR-665	7/22/1982	CO	Larimer	Flood	FLASH FLOOD DUE TO DAM FAILURE	7/22/1982	---
DR-541	11/7/1977	GA	Stephens	Flood	DAM COLLAPSE, FLOODING	11/7/1977	---
DR-505	6/6/1976	ID	Bingham	Flood	DAM COLLAPSE, FLOODING	6/6/1976	
DR-505	6/6/1976	ID	Bonneville	Flood	DAM COLLAPSE, FLOODING	6/6/1976	
DR-505	6/6/1976	ID	Fremont	Flood	DAM COLLAPSE, FLOODING	6/6/1976	---
DR-505	6/6/1976	ID	Jefferson	Flood	DAM COLLAPSE, FLOODING	6/6/1976	
DR-505	6/6/1976	ID	Madison	Flood	DAM COLLAPSE, FLOODING	6/6/1976	
DR-379	5/8/1973	CO	Weld	Dam/ Levee Break	DAM FAILURE	5/8/1973	---
DR-161	12/21/1963	CA		Dam/ Levee Break	FLOOD DUE TO BROKEN DAM	12/21/1963	---

*No FEMA-based financial assessments are publicly available.

To date, the Municipality of Anchorage has not had a presidentially declared disaster caused by dam failure. While the number of dams within the Municipality of Anchorage is limited, sudden flooding hazards do exist. Dam failure could cause damage to critical infrastructure, property damage, and fatalities.

Ten dams were initially suggested for inundation assessments including Eklutna, Lake 'O' the Hills Dam, Lower Fire Lake, Campbell Lake, Westchester Lagoon, Lower Eklutna, Ship Creek, Gregory Lake, Otter Lake, and Explorer Glacier Pond. Spatial data for the following dams was provided: Eklutna Lake, Lake 'O' the Hills, and Lower Fire Lake. The 2011 Municipality of Anchorage HMP explains that the Lake 'O' the Hills Dam is a privately owned dam that impounds a recreational lake. Its creation diverted water from its original path to a recreational lake. The dam is located 8.6 miles from the Municipality of Anchorage and is built to an elevation of 827 feet. Lake 'O' the Hills Dam failed in 1972, resulting in one fatality. While only a limited number of dams exist within the Municipality of Anchorage, sudden flooding hazards do exist. Repeated failure of the Lake 'O' the Hills Dam could cause damage to critical infrastructure, property damage, and fatalities.

Dam Failure Exposure Assessment

For this study, the dam failure exposure assessment performed by the project team measured potential impacts of dam inundation based on the failure of dams. Dam flooding is estimated based on the inundation by floodwater of a specified area being protected by a dam or levee. Dam inundation areas vary based on the type of structure, location of structural element, and flooding source being addressed. Table 23 identifies areas vulnerable to flood inundation based on dam failure.

Table 23: Exposure Associated with Dam Failure within the Municipality of Anchorage

COMMUNITY NAME	TOTAL ESTIMATED VALUE (BUILDINGS AND CONTENTS IN DOLLARS)	TOTAL NUMBER OF IMPACTED BUILDINGS	EKLUTNA LAKE INUNDATION AREA		LAKE 'O' THE HILLS INUNDATION AREA		LOWER FIRE LAKE INUNDATION AREA	
			TOTAL DOLLAR LOSS	LOSS RATIO	TOTAL DOLLAR LOSS	LOSS RATIO	TOTAL DOLLAR LOSS	LOSS RATIO
Anchorage	$23.9B	16	---	---	$2.9M	0.00%	---	---
Chugiak	$663.0M	23	$8.8M	0.01%	---	---	---	---
Eagle River	$1.8B	130	---	---	---	---	$13.3M	0.01%

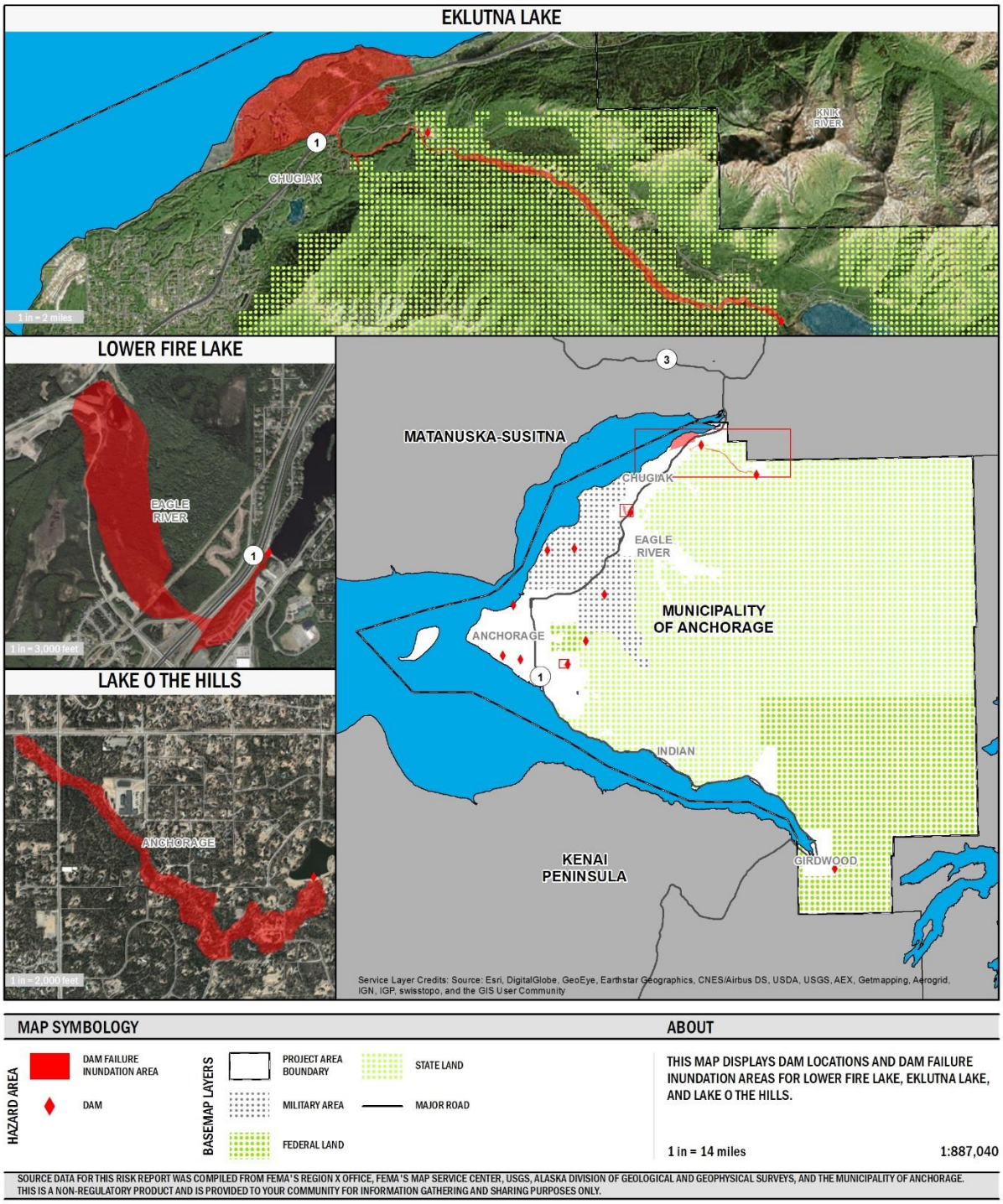
Note: Loss ratio is calculated by the dollar losses/total value.

An estimated 169 structures are identified as being at risk from one of three dam failure scenarios. Loss estimates associated with the Lower Fire Lake inundation area are greater than those estimated for the Eklutna Lake and Lake 'O' the Hills inundation areas. The total estimated dollar loss correlating with dam failure at the Lower Fire Lake inundation area is over $13 million. Both the Eklutna Lake and Lower Fire Lake inundation areas have a loss ratio of 0.01 percent, while the Lake 'O' the Hills inundation area has a loss ratio of 0.00 percent.

Communities can use the dam failure inventory assessment to identify properties for mitigation projects as well as areas for additional outreach. Areas of greatest impact and potential mitigation actions are discussed in Section 13, Areas of Mitigation Interest. All results, databases, and maps are provided in the Risk Assessment Database included with this Risk Report.

Map 11: Inundation and Loss Estimates for Lake 'O' the Hills Dam Failure

DAM FAILURE



9. Landslide Exposure Assessment

Landslide Hazard Overview

Landslides occur throughout the United States and can be caused by a variety of factors, including earthquakes, storms, volcanic eruptions, fires, and by human modification of land. Landslides can occur quickly, especially during wet winter months. Landslides usually occur in steep areas, but not exclusively. Ground failure of river bluffs, cut-and-fill failures associated with road and building excavations, collapse of mine-waste piles, and slope failures associated with open-pit mines and quarries can all cause landslides. Underwater landslides usually involve areas of low relief and slope gradients in lakes and reservoirs or in offshore marine settings.

The Municipality of Anchorage is particularly vulnerable to landslide in certain areas depending on ground failure susceptibility. The 1964 Good Friday earthquake triggered a wide variety of falls, slides, and flows through south-central Alaska. The Anchorage area was heavily impacted because of Bootlegger Cove clay failures. Some of the more significant events occurred at 4th Avenue, L Street, Government Hill, and Turnagain Heights. Several less-devastating slides occurred throughout town, including slides at Point Woronzof and Potter Hill. The Government Hill slide was a complex movement. Government Hill Elementary School was severely damaged by the translational slide. The south wing of the school dropped approximately 30 feet, while the east wing split lengthwise and collapsed. Part of this slide became an earth flow that spread 150 feet across the flats into the Alaska Railroad yards.

Table 24: Recent Presidentially Declared Landslide Disaster History for Alaska

DISASTER NUMBER	DECLARATION DATE	STATE	INCIDENT DESCRIPTION	TOTAL PUBLIC ASSISTANCE GRANTS - DOLLARS OBLIGATED	HMGP FUNDING - DOLLARS APPROVED FOR THE MUNICIPALITY OF ANCHORAGE
4094	11/27/2012	AK	Severe Storm, Straight-line winds, Flooding, and Landslides	$11,024,415.21	---
1865	12/18/2009	AK	Severe Storms, Flooding, Mudslides, and Rockslides	$3,856,115.99	---
1796	09/26/2008	AK	Severe Storms, Flooding, Landslides, and Mudslides	$12,186,818.01	$1,823,444.00
1669	12/08/2006	AK	Severe Storms, Flooding, Landslides, and Mudslides	$9,244,257.84	$1,112,877.00
1663	10/16/2006	AK	Severe Storms, Flooding, Landslides, and Mudslides	$9,169,973.30	$1,436,489.00
281	12/19/1969	AK	Heavy Rains, Landslide	None Available	None Available

Note: Dashes represent that funding was available statewide, but not specifically allocated to the Municipality of Anchorage.

Landslide Exposure Assessment

To estimate where landslide hazard occurrences could potentially affect properties within the Municipality of Anchorage, the project team performed a spatial analysis to identify vulnerable structures with an estimated potential loss based on exposure. For this exposure assessment, the team compared the locations of improved parcels to the geographic extent of deep transitional landslides (Jibson and Michael, 2009 from USGS). Spatial data for shallow landslide zones are not available. The results of the exposure assessment are shown in Table 25.

Table 25: Parcel Improvement Exposure Associated with Landslide in the Municipality of Anchorage

COMMUNITY NAME		TOTAL ESTIMATED VALUE (BUILDINGS AND CONTENTS IN DOLLARS)	TOTAL NUMBER OF BUILDINGS	DEEP, TRANSITIONAL LANDSLIDE ZONE		SHALLOW LANDSLIDE ZONE	
				TOTAL DOLLAR LOSS	LOSS RATIO	TOTAL DOLLAR LOSS	LOSS RATIO
Municipality of Anchorage	Anchorage	$57,545,398,213	5,088	$6,287,853,265	0.11%	*	*
	Chugiak	---	---	---	---	*	*
	Eagle River	---	---	---	---	*	*
	Girdwood	---	---	---	---	*	*
	Indian	---	---	---	---	*	*
AK Bureau of Land Management		---	---	---	---	*	*
Chugach State Park		---	---	---	---	*	*
Chugach National Forest		---	---	---	---	*	*
Elmendorf Air Force Base		$281,290,557	4	$16,200,569	0.06%	*	*
Fort Richardson Military Reservation		---	---	---	---	*	*
TOTAL		**$57,826,688,771**	**5,092**	**$6,304,053,835**	**0.11%**	*	*

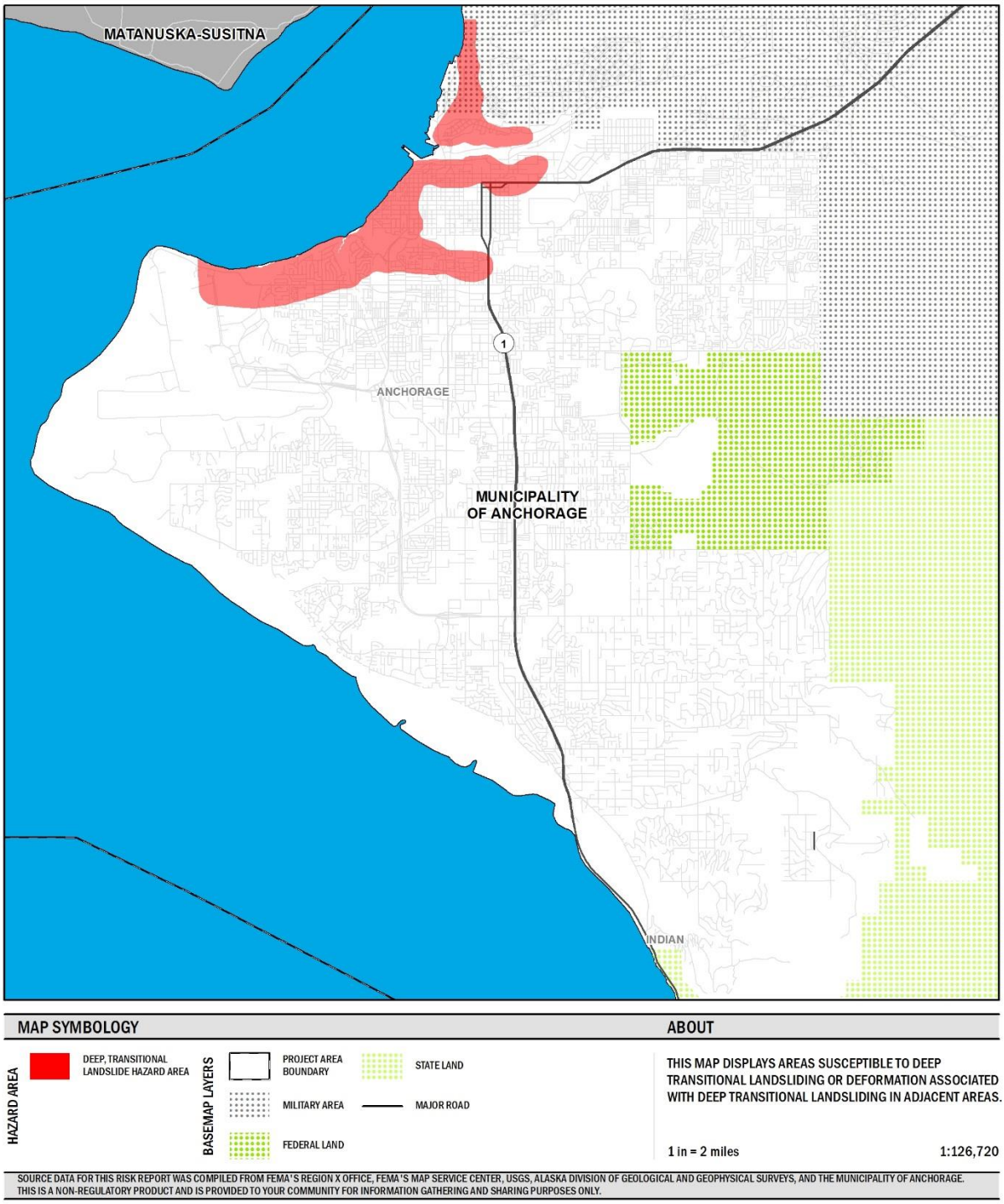
*Pending Municipality of Anchorage spatial data
Note: Loss ratio is the dollar losses/total value.

Approximately $6.3 billion of building and contents value (5,092 improved parcels) in the studied communities are at risk from a deep, transitional landslide hazard occurrence. Deep, transitional landslide risk produces more loss than shallow landslide occurrences. A translational slide is a landslide where the mass moves along a somewhat planar (flat) surface with little rotation or backward tilting. This can cause the mass to build up, resulting in a relatively coherent, heavy mass slide. Only 0.11 percent of the vulnerable buildings are exposed to this type of hazard event. Anchorage and Elmendorf Air Force Military Reservation receive the majority of damage from potential landslide hazards.

Local officials can use the landslide inventory assessment to identify properties for mitigation projects as well as areas for additional outreach. Areas of greatest impact and potential mitigation actions are discussed in Section 13, Areas of Mitigation Interest. All results, databases, and maps are provided in the Risk Assessment Database included with this Risk Report.

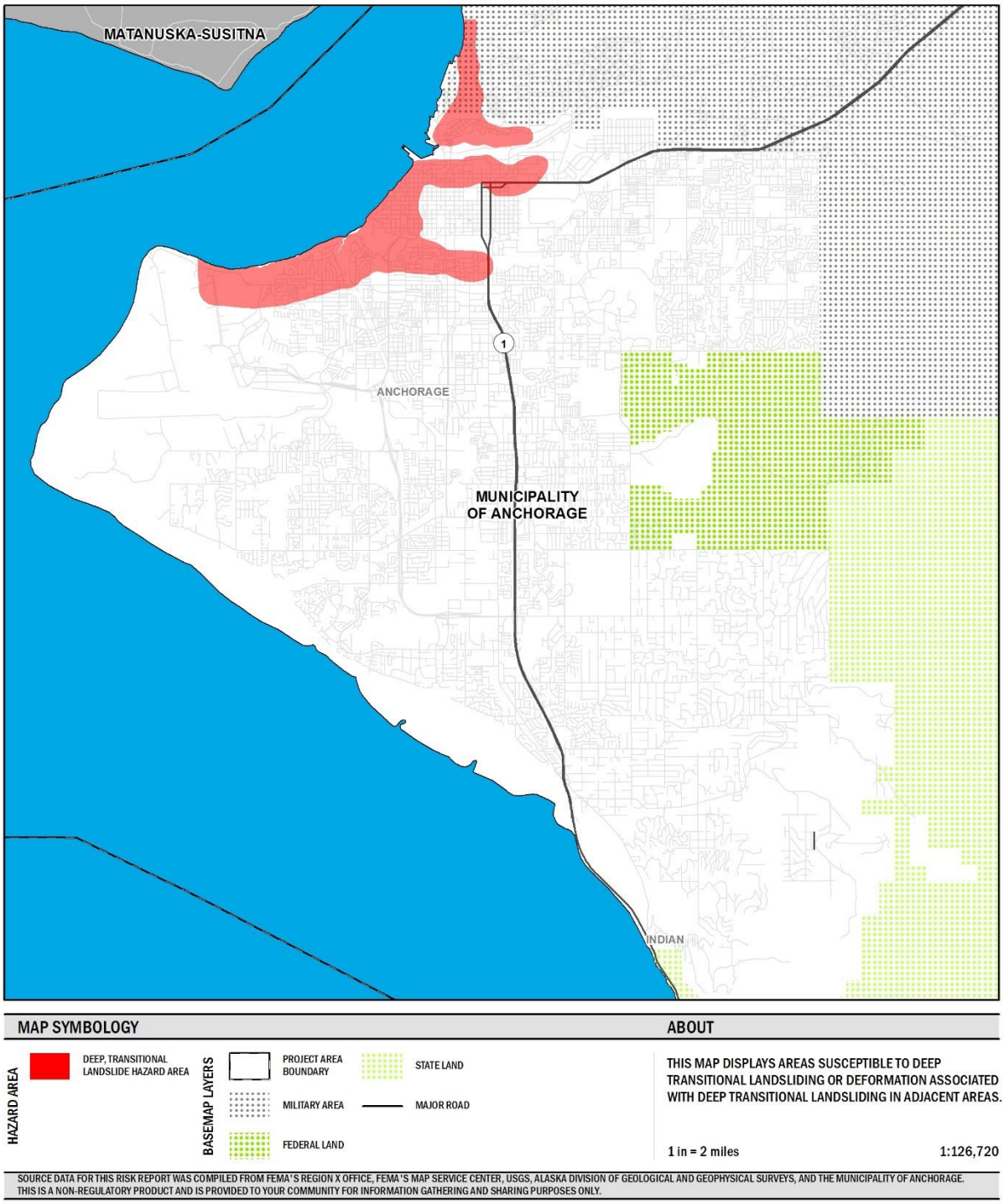
Map 12: Deep, Transitional Landslide Risk in the Municipality of Anchorage

LANDSLIDE



Map 13: Shallow Landslide Risk in the Municipality of Anchorage

LANDSLIDE



10. Wind Exposure Assessment

Wind Hazard Overview

Extreme winds other than tornadoes occur in all regions of the United States. A straight-line wind is generally any wind that is not associated with rotation (i.e., not a tornado). These high winds can vary from zero to 200 mph. High-wind events do not have narrow tracks like tornadoes; therefore, the associated wind damage can be extensive and affect larger areas. Objects like trees, structures, vehicles, and power lines/power poles can be collapsed or destroyed, and roofs, windows, and residences can be damaged by an increase in high-wind occurrences.

A strong wind can vary between 45 and 72 mph. Within the Municipality of Anchorage, these high winds can contribute to dangerously high wind chill temperatures and, when combined with loose snow, can produce blinding blizzard conditions. Typically, high-wind warnings are for the Hillside area and along Turnagain Arm. These areas commonly get high winds, but the impacts are not that great until the winds exceed 85 mph. When winds exceed 85 mph, it is not unusual for widespread damage to occur, especially along the Hillside and in East Anchorage when the winds exceed 100 mph. Less intense winds (50 to 60 mph) have a greater impact in the downtown areas. High wind can occur within the Municipality of Anchorage based on the Chugach wind that blows off the Chugach Mountains, mostly affecting the eastern side of the Anchorage Bowl. The high winds in the Turnagain Arm area can affect traffic on the New Seward Highway. Winds near McHugh Creek have the potential to range from 80 to 90 mph. A Knik Valley wind brings warm air from Prince William Sound. Hillside areas can experience a Chinook/Chugach wind. Eagle River can get winds from the southeast. Localized winds in Bear Valley can reach 125 mph.

As shown in Table 26, Alaska has experienced two presidentially declared disasters related to straight-line winds. For DR 4162, the high-wind event occurred in conjunction with severe storms and flooding. For DR 4094, the high-wind event occurred in conjunction with severe storms, flooding, and landslides.

Table 26: Presidentially Declared Straight Line Wind Disaster History for Alaska

DISASTER NUMBER	DECLARATION DATE	STATE	INCIDENT DESCRIPTION	INCIDENT BEGIN/END DATE	TOTAL PUBLIC ASSISTANCE GRANTS - DOLLARS OBLIGATED*
DR 4162	01/23/2014	AK	Severe Storms, Straight-Line Winds, and Flooding	11/14/2013	$19,244,581.91
DR 4094	11/27/2012	AK	Severe Storm, Straight-Line winds, Flooding, and Landslides	09/30/2012	$11,024,415.21

Wind Exposure Assessment

Wind risk within the Municipality of Anchorage is associated with wind speed, which the project team divided into four separate zones based on 3-second gusts. Wind Risk data was obtained from the City of Anchorage. For this exposure assessment, the team compared locations of improved parcels to the geographic extent of high wind. The results of the assessment are summarized in Table 27.

Table 27: Parcel Improvement Exposure Associated with High-Wind Events in the Municipality of Anchorage

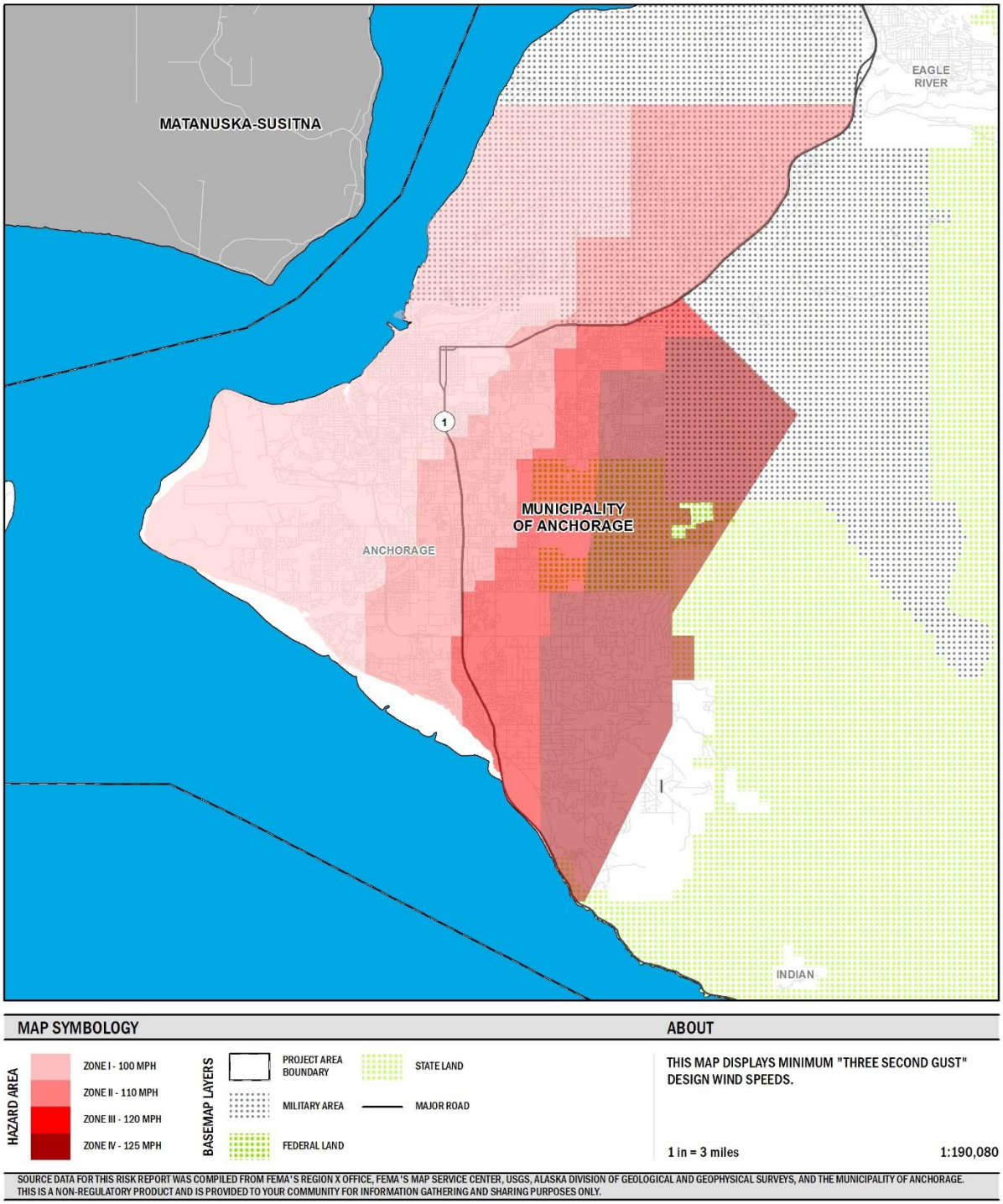
COMMUNITY NAME		TOTAL ESTIMATED VALUE (BUILDINGS AND CONTENTS IN DOLLARS)	ZONE I 3-SECOND GUST: 100 MPH		ZONE II 3-SECOND GUST: 110 MPH		ZONE III 3-SECOND GUST: 120 MPH		ZONE IV 3-SECOND GUST: 125 MPH	
			BUILDING VALUE	PERCENT BUILDING VALUE	BUILDING VALUE	PERCENT BUILDING VALUE	BUILDING VALUE	PERCENT BUILDING VALUE	BUILDING VALUE	PERCENT BUILDING VALUE
Municipality of Anchorage	Anchorage	$57.6B	$26.2B	45.57%	$15.4B	26.69%	$9.7B	16.77%	$6.1B	10.68%
	Chugiak	$1.7B	---	---	---	---	---	---	---	---
	Eagle River	$4.8B	---	---	---	---	---	---	---	---
	Girdwood	$513.7M	---	---	---	---	---	---	---	---
	Indian	$69.0M	---	---	---	---	---	---	$252,979	0.37%
AK Bureau of Land Management		$417.4M	---	---	---	---	$276.8M	66.32%	$79.5M	19.06%
Chugach State Park		$52.8M	---	---	---	---	---	---	---	---
Chugach National Forest		$111.0M	---	---	---	---	---	---	---	---
Elmendorf Air Force Base		$281.3M	$20.3M	7.23%	$256.0M		$5.0M	1.75%	---	---
Fort Richardson Military Reservation		$331.4M	---	---	$152.1M	45.89%	$153.7M	46.38%	---	---
TOTAL		**$66.0B**	**$26.2B**	**39.82%**	**$15.8B**	**23.93%**	**$10.1B**	**15.30%**	**$6.2B**	**9.45%**

Most of the estimated building and contents values are in the Zone I 3-second gust area ($26 billion). Zone I is comprised of 3-second wind gusts over 100 mph. Zone II (110-mph wind gusts) and Zone III (120-mph wind gusts) include $15.7 and $10.1 billion in building and contents values, respectively. Zone IV (3-second wind gusts of 125 mph) contains $6.2 billion in building and contents values. Chugiak, Eagle River and Girdwood are not subject to high wind hazards. High wind hazards have the potential to impact various regions within the Municipality of Anchorage, including downtown and populated areas.

Local officials can use the high-wind inventory assessment to identify areas for mitigation action. The areas of impact are discussed in the Section 13, Areas of Mitigation Interest. All results, databases, and maps are provided in the Risk Assessment Database included with this Risk Report.

Map 14: 3-Second Wind Gust Zones in the Municipality of Anchorage

WIND



11. Wildfire Exposure Assessment

Wildfire Hazard Overview

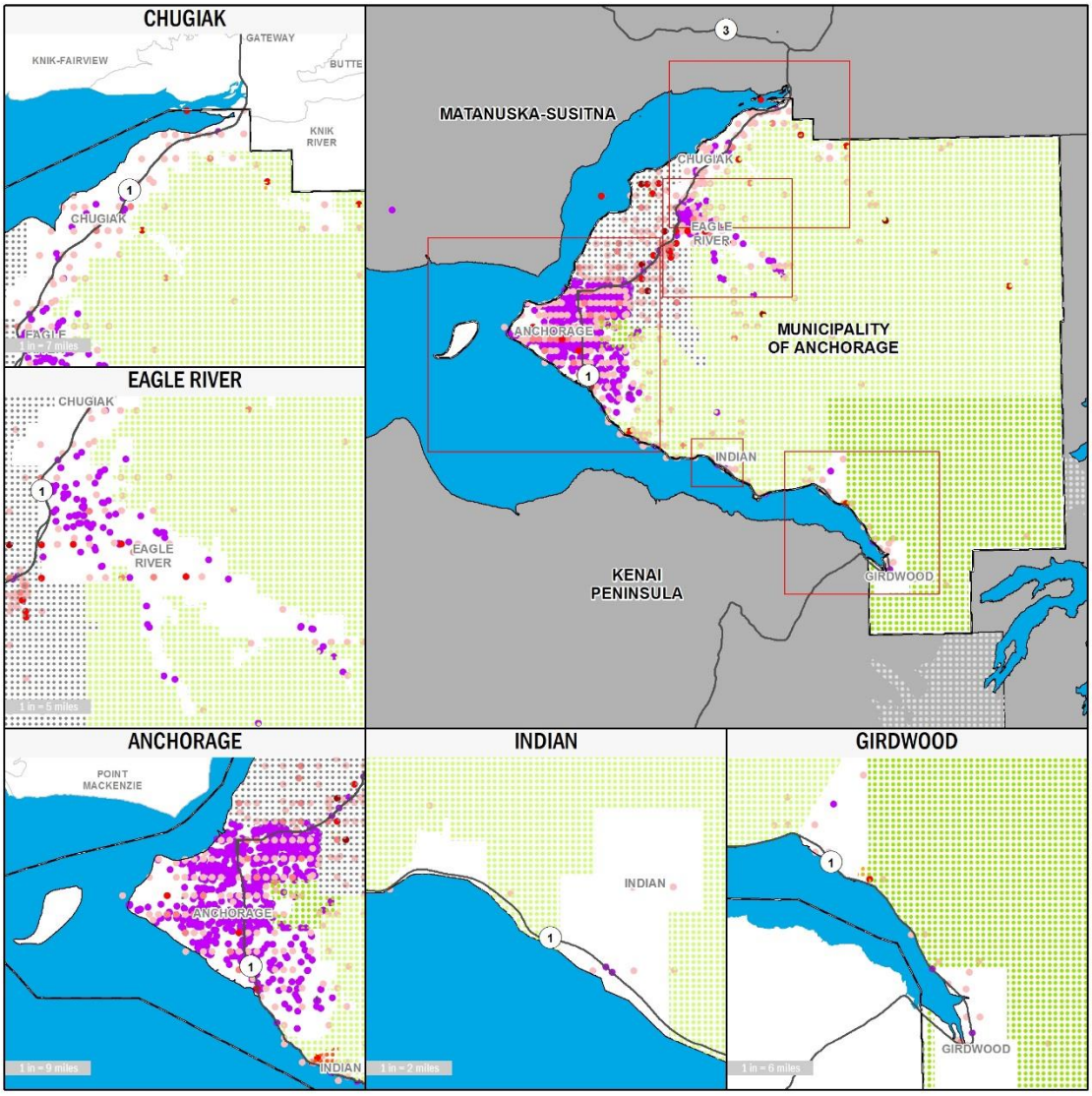
Wildfires are defined as fires that rage out of control in the wilderness, like a forest or countryside. Wildfires are common in wildland settings, where the initiation may often begin unnoticed, promoted by outside influences such as lightening or human-caused disturbance. These hazard events can occur at any time throughout the year, but have higher potential during periods of drought or little rainfall. High winds can also contribute to the spreading of fire. Wildfires spread quickly, igniting brush, trees, and homes.

The Municipality of Anchorage's location in the boreal forest causes concerns about risk. Fuel, weather, and topography influence wildland fire behavior. The amount of fuel determines how much energy the fire releases, how quickly the fire spreads, and how much effort is needed to contain the fire. The primary fuels in wildland fires are living and dead vegetation. Weather is the most variable and uncontrollable factor in wildland fire fighting. Weather includes temperature, relative humidity, wind, and precipitation. High temperatures and low humidity encourage fire activity, while low temperatures and high humidity help retard fire behavior. Wind dramatically affects fire behavior and is a critical factor in the spread and control of the fire. Topography directs the movement of air, which can also affect fire behavior. When the terrain funnels air, as in a canyon, it can result in a faster-spreading fire.

No declared wildfire disasters have been identified in the Municipality of Anchorage. However, the potential exists. Every year, the Anchorage Fire Department puts out dozens of fires that could have been disastrous if not contained early. Between 2001 and 2009, the number of wildfires per year in the Municipality of Anchorage ranged from 82 fires in 2006 to 150 fires in 2002. Between 2001 and 2006, the Municipality of Anchorage had 622 wildfire calls that burned approximately 200 acres (Anchorage All Hazards Mitigation Plan, 2011). Most recently, in the summer of 2016, 778 acres burned south of Anchorage after a campfire was left unattended (Alaska Division of Forestry). This became known as the McHugh Fire. The fire resulted in temporary closures of the Chugach State Park and the Seward Highway, and caused flight restrictions in the fire area. Fire crew efforts and wet weather suppressed the flames, and no structures were damaged. Map 15 provides a visual of past fire incidents documented by the Borough of Land Management, and the Municipality of Anchorage, and includes the McHugh fire footprint.

Map 15: Historic Wildfire Incidents within the Municipality of Anchorage

WILDFIRE



12. Plan Integration

The information in this Risk Report is intended to support the ongoing planning processes within the Municipality of Anchorage, including those for the comprehensive plan and the All-Hazards Mitigation Plan HMP. Because the communities within the Municipality of Anchorage are included in both the Anchorage comprehensive plan and the HMP, this Risk Report focuses primarily on resiliency strategies for the Municipality as a whole. The comprehensive plan recognizes that there are natural hazard risks, and it describes the need to continue coordination with emergency plans and procedures and develop educational programs that minimize the risk to the community from natural hazards. The information in this section of the Risk Report encourages further plan integration to incorporate more natural hazard information in land use plans, to use the Risk Report data/information in stakeholder and plan development for increased information sharing among departments, and to advocate for coordination of all plan updates. Changes to evacuation routes, future planned development areas, continuity of operations plans, and conservation and restoration priorities for natural resources are some examples of how increased communication around natural hazards and plan integration could support a community.

The objectives of the comprehensive plan and the HMP already complement each other. A few objectives from the HMP are:

- Objective 1.5: Educate public officials, developers, realtors, contractors, building owners, and the general public about hazard risks and building requirements.
- Objective 2.4: Adopt and enforce public policies to minimize the impacts of development and enhance safe construction in high hazard areas.
- Objective 5.3: Promote vegetation management in greenbelts and parks to limit fire spread.

Page 5-4 of the Anchorage HMP lists land-use planning mechanisms and recognizes that community officials can use the information in the plan to inform other planning programs. The information in this Risk Report could be integrated into this section and integrated into all sections. These sections are critical area regulation, growth management, capital improvement, and water resource inventory area planning.

Within land-use planning, local officials could use the data/information in this Risk Report and the HMP to update elements of the comprehensive plan, such as existing conditions, community history, future land use, conservation and natural resources, public facilities/services, transportation, housing, historic preservation, economic development, recreation and open space, and public safety. Specific objectives from the Municipality of Anchorage comprehensive plan that this information could help address are:

- Harmony with Nature: An urban place that develops in harmony with its natural setting and is mindful of its natural hazards.
- New rural residential subdivisions shall be designed to protect, maintain, or avoid sensitive environmental areas such as wetlands, steep slopes, drainageways, unsuitable soils, and geohazard areas; and incorporate wildland fire safety design standards.
- The Municipality shall minimize the incidence of new developments for human occupancy in high natural hazard areas.

The project team developed the resilience strategies included in Section 13. Areas of Mitigation Interest to be consistent with the goals and purpose of the HMP and the components of the comprehensive plan. While hazards are mentioned in Chapter 5 of the comprehensive plan, local officials have a strategic

opportunity to write in a stronger connection to the HMP, or discuss more policies and strategies related to reducing risk to natural hazards.

The resilience strategies presented in the Risk Report also reflect changing population and development trends, explained in the comprehensive plan; the demands for rapid growth have declined, quality of life issues have become a priority, and there is a need to extend infrastructure efficiently in the limited remaining opens spaces in the Municipality. These changes, along with changes in development patterns, should help inform updates to mitigation strategies in the HMP (for example, updating a focus of the strategies to address new structures that will meet the demands for housing, commercial development, public open spaces, roads, and public facilities with a limited supply of land). Additionally, the need to make more efficient use of existing structures will require building standards that take seismic and flooding hazards into consideration. The information in this Risk Report is provided to support updates to building codes and ordinances to be consistent with the inclusion of hazards in the higher-level plans. For example, adding additional hazard information to the Municipality of Anchorage Permit, Planning, and Zoning Map.

The comprehensive plan includes components that help to guide the vision for the Municipality: Land Use Concept Plan, Land Use Policy Map, Growth and Allocation Map, Conceptual Natural Open Space Map, and Transportation Planning-Next Steps. Hazard mitigation can be integrated into each one of these components. The information in this Risk Report is provided to support the Municipality's ongoing land-use planning and hazard mitigation efforts. The resiliency strategies included in Section 13, Areas of Mitigation Interest, were developed to fit in with the goals and purpose of the HMP and the comprehensive plan. The AOMI resilience strategies were established with land use planning goals in mind; the strategies incorporate primary components of the HMP, including stakeholder engagement, public participation, hazard profiles and mitigation actions.

The stakeholder engagement and public participation in the HMP could be increased when the plan is updated. The HMP provides a broad assessment of risk. The Risk MAP process can complement the plan by providing additional information about risk from natural hazards. The plan developers can help disseminate the information found in this Risk Report so it can be used to inform community plan updates. The relationships between this Risk Report and local plans can also be the foundation for local representative participation, community outreach, and hazard awareness campaigns that aim to increase preparedness for many types of natural hazards. The same outlets used to gather public participation and provide comment (e.g., names, surveys, organizations) are included in the HMP as existing avenues to use for sharing the updated information with stakeholders. These networks also could be used to identify local Community Emergency Response Teams and other local champions who are passionate about reducing risk in their communities, where they have unique knowledge about how to reach out to different audiences.

The project team developed the resilience strategies discussed in Section 13, Areas of Mitigation Interest, using land use and hazard mitigation information in local plans. The advocacy of a local champion or a strategic outreach network will enhance these strategies. The team designed these strategies to be as consistent as possible with the existing planning mechanism and with the goals and objectives of both the comprehensive plan and the HMP. These strategies also have been intentionally written to provide supportive information to help update the comprehensive plan and the HMP.

13. Areas of Mitigation Interest

Municipality of Anchorage

Areas of Mitigation Interest and Recommended Resilience Strategies

The project team completed an assessment of the Municipality of Anchorage based on Hazus earthquake models and exposure assessments in mapped 0.2-percent-annual-chance and 1-percent-annual-chance flood hazard areas, areas where wildfires have historically occurred, and avalanche, dam failure, landslide, and wind hazard areas. Table 28 highlights facilities in the Municipality of Anchorage that FEMA's analysis show to be most affected by these hazards.

Table 28: Municipality of Anchorage Areas of Mitigation Interest

LOCATION	CATEGORY	NAME	TOTAL VALUE (BUILDING AND CONTENTS)	ESTIMATED LOSS FROM M7.2 EARTHQUAKE	M7.2 EARTHQUAKE LOSS RATIO	IDENTIFIED HAZARDS
ANCHORAGE	EOC	ANCHORAGE EMERGENCY OPERATIONS CENTER	$68,658,180	$1,402,320	2.04%	EARTHQUAKE
ANCHORAGE	FIRE	ANCHORAGE FIRE STATION 3	$54,129,820	$1,042,780	1.93%	EARTHQUAKE
ANCHORAGE	FIRE	ANCHORAGE FIRE STATION 4	$9,016,580	$164,730	1.83%	EARTHQUAKE
ANCHORAGE	SCHOOL	PAIDEIA COOPERATIVE SCHOOL	$14,285,230	$257,520	1.80%	EARTHQUAKE
ANCHORAGE	SCHOOL	WILLIAM TYSON ELEMENTARY SCHOOL	$24,009,160	$416,910	1.74%	EARTHQUAKE
ANCHORAGE	SCHOOL	MEARS MIDDLE SCHOOL	$67,616,130	$1,174,140	1.74%	EARTHQUAKE
ANCHORAGE	SCHOOL	TUDOR ELEMENTARY SCHOOL	$24,055,530	$392,160	1.63%	EARTHQUAKE, FLOODING
ANCHORAGE	SCHOOL	STELLAR SECONDARY SCHOOL	$18,839,480	$307,130	1.63%	EARTHQUAKE
ANCHORAGE	SCHOOL	UNIVERSITY OF ALASKA ANCHORAGE	$34,082,250	$547,250	1.61%	EARTHQUAKE
ANCHORAGE	EOC	ANCHORAGE EMERGENCY OPERATIONS CENTER	$68,658,180	$1,402,320	2.04%	EARTHQUAKE
CHUGIAK	FIRE	CHUGIAK VOLUNTEER FIRE STATION 32	$649,100	$7,810	1.20%	EARTHQUAKE

LOCATION	CATEGORY	NAME	TOTAL VALUE (BUILDING AND CONTENTS)	ESTIMATED LOSS FROM M7.2 EARTHQUAKE	M7.2 EARTHQUAKE LOSS RATIO	IDENTIFIED HAZARDS
CHUGIAK	FIRE	CHUGIAK VOLUNTEER FIRE STATION 33	$678,170	$6,320	0.93%	EARTHQUAKE
CHUGIAK	SCHOOL	MIRROR LAKE MIDDLE SCHOOL	$71,926,930	$581,120	0.81%	EARTHQUAKE
CHUGIAK	FIRE	CHUGIAK VOLUNTEER FIRE STATION 31	$2,582,270	$15,480	0.60%	EARTHQUAKE
CHUGIAK	SCHOOL	BIRCHWOOD ELEMENTARY SCHOOL	$148,863,910	$852,250	0.57%	EARTHQUAKE
CHUGIAK	SCHOOL	CHUGIAK ELEMENTARY SCHOOL	$24,959,950	$135,890	0.54%	EARTHQUAKE
EAGLE RIVER	POLICE	ANCHORAGE POLICE DEPARTMENT SUBDIVISION	$8,745,160	$91,110	1.04%	EARTHQUAKE
EAGLE RIVER	FIRE	ANCHORAGE FIRE STATION 11	$921,450	$8,810	0.96%	EARTHQUAKE
EAGLE RIVER	SCHOOL	EAGLE RIVER ELEMENTARY SCHOOL	$19,830,490	$165,760	0.84%	EARTHQUAKE
EAGLE RIVER	SCHOOL	HOMESTEAD ELEMENTARY SCHOOL	$23,821,620	$184,290	0.77%	EARTHQUAKE
EAGLE RIVER	SCHOOL	EAGLE ACADAMEY CHARTER SCOOL	$9,987,480	$70,450	0.71%	EARTHQUAKE
EAGLE RIVER	FIRE	CHUGIAK VOLUNTEER FIRE STATION 35	$6,279,370	$35,610	0.57%	DAM FAILURE, EARTHQUAKE, FLOODING
EAGLE RIVER	SCHOOL	RAVENWOOD ELEMENTARY SCHOOL	$21,441,140	$116,210	0.54%	EARTHQUAKE
EAGLE RIVER	SCHOOL	ALPENGLOW ELEMENTARY SCHOOL	$24,272,600	$131,560	0.54%	EARTHQUAKE
EAGLE RIVER	SCHOOL	GRUENING MIDDLE SCHOOL	$51,237,560	$270,710	0.53%	EARTHQUAKE

LOCATION	CATEGORY	NAME	TOTAL VALUE (BUILDING AND CONTENTS)	ESTIMATED LOSS FROM M7.2 EARTHQUAKE	M7.2 EARTHQUAKE LOSS RATIO	IDENTIFIED HAZARDS
EAGLE RIVER	FIRE	SOUTH FORK VOLUNTEER FIRE	$1,324,240	$5,750	0.43%	EARTHQUAKE, FLOODING
EAGLE RIVER	POLICE	ANCHORAGE POLICE DEPARTMENT SUBDIVISION	$8,745,160	$91,110	1.04%	EARTHQUAKE
GIRDWOOD	FIRE	GIRDWOOD FIRE DEPARTMENT STATION 41	$9,285,180	$11,330	0.12%	EARTHQUAKE, FLOODING

Note: Hazards are considered identified if the following applies:

1. Earthquake: Subject is at risk to earthquake regardless of estimated loss
2. Flood: Subject is within a 0.2-percent-annual-chance or 1-percent-annual-chance flood hazard area
3. Avalanche: Subject is within a parcel along an identified avalanche hazard area
4. Dam Failure: Subject is within a dam failure inundation area
5. Landslide: Subject is within a deep, transitional landslide hazard area
6. Wind: Subject is within a Zone III or IV wind area

Subjects with the location of Anchorage were limited to a M7.2 earthquake loss ratio of 1.5 percent or higher.

Center for Climate and Energy Solutions (C2ES) Disaster Resilience Workshop and Risk MAP

The Center for Climate and Energy Solutions (C2ES) hosted a Disaster Resilience Workshop in Anchorage March 29-30th of 2016. The goal of the workshop was to assess the Municipality's resilience according to the "Ten Essentials" of Disaster Resilience according to the publication by the United Nation's International Strategy for Disaster Reduction (UN ISDR). Attendees of the workshop included representatives from the State, Municipality, Port of Anchorage, utilities, local businesses, environmental organizations, economic organizations, tribal organizations, and other local stakeholders.

The Workshop resulted in the completion of a scorecard based on the "Ten Essentials" and documented local needs and conclusions for each criteria. The below table lists the C2ES conclusion for each of the "Ten Essentials" and provides an explanation, where applicable, of how the Risk MAP data and process can support the results of the C2ES Workshop.

Table 29: "Ten Essentials" of Disaster Resilience and Connections to Risk MAP

ESSENTIAL #	C2ES CONCLUSION	FEMA RISK MAP SUPPORT
1	Organize for Resilience: Anchorage has a strong organizational foundation for disasters, having experienced earthquakes and other events. Long-term resilience to climate change has been less covered, and the municipality could strengthen coordination externally (e.g., with neighboring jurisdictions, community groups, the private sector).	Generally, climate change models in Alaska predict a warming trend in temperatures and longer duration of precipitation events with higher intensities. This could result in larger, more frequent flooding events, and warmer summers with a higher probability of wildfires. The Risk MAP data can be used to further assess flood and wildfire risk and vulnerabilities, as well as to inform land use planning decisions by identifying at-risk infrastructure and populations to different scenarios and implementing regulations with higher building standards in identified high risk areas.

ESSENTIAL #	C2ES CONCLUSION	FEMA RISK MAP SUPPORT
		Additionally, this analysis can assist with focusing outreach activities with targeted audiences and geographic areas.
2	Identify, Understand, and Use Current and Future Risk Scenarios: Anchorage has a good understanding of acute shocks (e.g., earthquakes, wildfires) and has planned for these events, but chronic stresses (e.g. coastal erosion, changes in hydrology) are less understood and planned for.	The Risk MAP data can enhance existing understanding of acute shocks. This data should be reviewed by the local emergency planning committee (LEPC), integrated into the next update of the Municipality's Hazard Mitigation Plan, and can facilitate the planning committee's discussion on risk and vulnerability to more chronic stresses and whether they should also be added into the local Hazard Mitigation Plan.
3	Strengthen Financial Capacity for Resilience: Anchorage's financial planning for resilience, its understanding of the costs and benefits of resilience investments, and its use of incentives, collectively represent the weakest of the "Ten Essential" areas reviewed. There is no "financial atlas" of where funding for resilience purposes may come from, that embraces all possible public and private sources.	The data developed through the Risk MAP process can be used to support cost benefit analysis of risk reduction strategies. For example, the loss estimations provided through the Hazus earthquake modeling can be used to explore the costs and benefits of seismic retrofitting. State subject matter experts present at the Risk MAP resilience Workshop can provide guidance on available grant funding to support risk reduction activities.
4	Pursue Resilient Urban Development: Design standards and building codes in Anchorage focus on resilience to earthquakes, and have not yet taken other types of resilience into account. Green infrastructure is one area that could also be used more.	The Risk MAP data can support cost-benefit analysis for changes in regulations and standards. For example, the avalanche risk assessment data can be used to support discussions regarding the adoption of an avalanche ordinance. The Risk MAP Resilience Workshop will bring Building Science subject matter experts and materials to allow for further consultation and coordination.
5	Safeguard Natural Buffers to Enhance the Protective Functions Offered by Natural Ecosystems: Anchorage has some information on the recreational and tourism benefits of ecosystems, but no information on the resilience benefits. Much of the existing research on ecosystems has focused on rural Alaska.	FEMA has published material on the natural and beneficial functions of floodplains. The publication explores the valuable functions of pristine or restored floodplains and their contributions to flood reduction and prevention. FEMA can bring a hard copy of this information to the Risk MAP Resilience Meeting.
6	Strengthen Institutional Capacity for Resilience: Internal municipal coordination on planning and resilience is stronger than coordination with external partners. Anchorage could take steps to improve outreach to residents, community groups, the private sector, etc.	Risk MAP data can be used to conduct targeted outreach to businesses and homeowners specific to the hazards they are vulnerable to. Additionally, FEMA has developed multiple outreach resources which the Municipality can leverage to conduct outreach activities.
7	Increase Societal and Cultural Resilience: Because of existing economic and social issues in Anchorage, the societal and cultural capacity for resilience—r connectedness- is low. The city has a very diverse population with almost 100 different languages in a city with around 300,000 people. The municipality could work with existing community networks to conduct outreach, education, and trainings on various issues.	Hazard-specific outreach materials are available from FEMA and can be translated into several languages. Additionally, FEMA and the State offer trainings and additional outreach materials. These needs can be discussed during the Risk MAP Resilience Meeting.
8	Increase Infrastructure Resilience: The state's reliance on Anchorage for its infrastructure, the lack of redundancy, and limited entry points make the city's critical infrastructure (e.g., the port) vulnerable to disasters. Increased coordination among groups and infrastructure improvements will be increasingly necessary for planning.	The Risk MAP Resilience meeting can serve as a coordination opportunity between these various groups to begin discussing risk reduction goals and strategies. Additionally, the local mitigation planning team can coordinate annual meetings to discuss and implement these strategies.
9	Ensure Effective Disaster Response: Anchorage is tactically strong because of the city's experience with	Review of the Risk MAP Areas of Mitigation Interest (in the above table) with first responders can help facilitate discussion on

ESSENTIAL #	C2ES CONCLUSION	FEMA RISK MAP SUPPORT
	disaster response, and therefore has coordinated across various groups for pre-planning and responding. There are some strategic weaknesses that could be addressed through additional coordination, involvement, and outreach, for example in drills and trainings.	critical facilities and inherent vulnerabilities. This data can be used to support emergency planning, including disaster exercises, emergency response plans and evacuation plans. Additionally, the local mitigation planning team can include first responders in their annual review and update process of the hazard mitigation plan.
10	Expedite Recovery and Build Back Better: Anchorage is stronger on relief than recovery, and could benefit from additional scenarios of events that could occur and from exploring how to recover from those events.	The risk assessments documented in the Risk MAP Risk Report can be used as the basis for exercise scenario development. Additionally, the FEMA Risk MAP Resilience Workshop will bring State and Federal subject matter experts on recovery to support efforts of the Municipality of Anchorage.

Hazard Mitigation Plan and Comprehensive Plan Analysis

The Municipality of Anchorage All-HMP, effective August 2011, and the Anchorage 2020 Comprehensive Plan identify some of the hazard mitigation projects in Table 30 that can be aided by information in this Risk Report.

Table 30: Municipality of Anchorage All-Hazard Mitigation Plan and Comprehensive Plan Analysis

RISK REPORT DATA	RISK REPORT DATA CAN SUPPORT THE FOLLOWING			RISK REPORT LINK
	PLAN TYPE	PLAN LINK	PROJECTS	
Flood Hazard Area: Spatial data identifies flood hazard areas for 1-percent-annual-chance and 0.2-percent-annual-chance events (only properties in Anchorage, Chugiak, Eagle River, Girdwood, Indian and the AK Bureau of Land Management with buildings [improvements] were incorporated into the analysis). **Hazus Flood Output:** Spatial and tabular data provide specific building and content loss data for properties affected by flooding (select areas of Anchorage, Chugiak, Eagle River, Fort Richardson, and Girdwood).	Hazard Mitigation Plan	Action 33	The Municipality of Anchorage shall continue to apply floodplain management regulations for development in the floodplain and floodway.	Host or link to new flood hazard data and Hazus flood outputs on local permitting website. Use data to prioritize development standards, code enforcement, NFIP enrollment, and educational outreach.
	Comprehensive Plan	Water Resources Policy 70	The ecological and drainage functions of Anchorage's aquatic resources shall be protected and, where appropriate, restored.	Promote new flood hazard data to the public through existing local events. Show flood hazard areas and how development decisions are made based on hazard information. In areas with repetitive loss properties, consider a buyout program to restore the land back to a natural drainage system.
Earthquake ShakeMap: Spatial data provide shaking intensity and ground motion following an earthquake. Data provided for M7.1 Border Rangers Fault Scenario, M7.2 Intraplate	Hazard Mitigation Plan	Action 20	Pursue funding to seismically retrofit Municipality of Anchorage-owned facilities that will be needed during and after a hazard.	Use Hazus earthquake output and AOMI section to review loss ratios to critical facilities for provided earthquake scenarios. Use the loss information to prioritize retrofit projects.

RISK REPORT DATA	RISK REPORT DATA CAN SUPPORT THE FOLLOWING			RISK REPORT LINK
	PLAN TYPE	PLAN LINK	PROJECTS	
Scenario, and M7.5 Castle Mountain Scenario. **Hazus Earthquake Output:** Spatial and tabular data provide specific building and content loss data for properties affected by the M7.1 Border Ranges Scenario, M7.2 Intraplate Scenario, and M7.5 Castle Mountain Scenario.	Comprehensive Plan	Residential Policy 13-c	New rural residential subdivisions shall be designed to protect, maintain, or avoid sensitive environmental areas (wetlands, steep slopes, drainageways, unsuitable soils, geohazard areas).	Host or link to new earthquake ShakeMap hazard data and Hazus outputs on local permitting website. Use data to prioritize development standards, code enforcement, structure relocation, and educational outreach.
Avalanche Risk Assessment: Spatial and tabular data identify building and content loss for structures located within the avalanche hazard area in Anchorage, Chugiak, Eagle River, Girdwood, Chugach State Park, and Chugach National Forest.	Hazard Mitigation Plan	Action 41	Update snow avalanche mapping for Chugiak/Eagle River, Anchorage Bowl, and Turnagain Arm/Girdwood.	Incorporate avalanche Risk Report Risk Database spatial and tabular data into updated snow avalanche maps.
	Comprehensive Plan	Water Resources Policy 70	The Municipality shall minimize the incidence of new developments for human occupancy in high [avalanche] natural hazard areas.	Use the avalanche risk assessment to identify areas prone to avalanche hazards. Regulate and/or restrict new development in these areas.
Dam Failure Risk Assessment: Spatial and tabular data identify building and content loss for structures located within inundation areas caused by the failure of the Eklutna Lake, Lake 'O' the Hills, and Lower Fire Lake dams. Impacted buildings were located in Anchorage, Chugiak, and Eagle River.	Hazard Mitigation Plan	Action 42	Map estimated dam inundation areas within the Municipality and evaluate alternative methods to mitigate the potential risk of a dam failure in these areas.	Incorporate dam failure Risk Report Risk Database spatial and tabular data into updated dam inundation maps.
	Comprehensive Plan	Water Resources Policy 70	The Municipality shall minimize the incidence of new developments for human occupancy in high [dam failure] natural hazard areas.	Use the dam failure risk assessment to identify areas prone to dam failure inundation hazards. Regulate and/or restrict new development in these areas.
Landslide Risk Assessment: Spatial and tabular data identify building and content loss for structures located within deep transitional landslide zones in Anchorage and on Elmendorf Air Force Base.	Hazard Mitigation Plan	Goal 1	Develop coordinated and proactive public policies, emergency plans and procedures, and educational programs that minimize the risk to the community from natural, technological, and human/social hazards and disasters [including landslides].	Use landslide hazard area special data within deep transitional landslides to prioritize educational outreach and mitigation actions to residents most affected by landslide events; prioritize the community of Anchorage and Elmendorf Air Force Base.
	Comprehensive Plan	Residential Policy 13-c	New rural residential subdivisions shall be designed to protect, maintain, or avoid sensitive environmental areas (wetlands, steep	Host or link to new landside hazard data and Hazus outputs on local permitting website. Use data to prioritize development standards, code

RISK REPORT DATA	RISK REPORT DATA CAN SUPPORT THE FOLLOWING			RISK REPORT LINK
	PLAN TYPE	PLAN LINK	PROJECTS	
			slopes, drainageways, unsuitable soils, geohazard areas).	enforcement, structure relocation, development restrictions and regulations, and educational outreach.
Wind Risk Assessment: Spatial and tabular data identify building and content loss for structures exposed to high wind. Wind gusts are measured in four zones based on 3-second gusts; Zone I - 100 mph, Zone II - 110 mph, Zone III - 120 mph, and Zone IV - 125 mph. Impacted communities included Anchorage, Indian, AK Bureau of Land Management, Elmendorf Air Force Base, and Fort Richardson Military Reservation.	Hazard Mitigation Plan	Goal 1	Develop coordinated and proactive public policies, emergency plans and procedures, and educational programs that minimize the risk to the community from natural, technological, and human/social hazards and disasters [including severe winds].	Use wind risk assessment hazard area special and tabular data within the communities most affected by high winds to prioritize educational outreach and mitigation actions; prioritize the communities of Anchorage and Indian, AK Bureau of Land Management, Elmendorf Air Force Base, and Fort Richardson Military Reservation.
	Comprehensive Plan	Water Resources Policy 70	The Municipality shall minimize the incidence of new developments for human occupancy in high [wind] natural hazard areas.	Host or link to new wind risk assessment hazard data on local permitting website. Use data to prioritize development standards, code enforcement, structure relocation, and educational outreach.
Wildfire Risk Assessment: A comprehensive assessment of wildfire risk was unable to be conducted in this report due to lack of data.	Hazard Mitigation Plan	Goal 5	Support wildfire mitigation. Support the AFD Wildfire Strategic Plan, promote FireWise homes and vegetation management, maintain wildfire risk model, and maintain and develop water resources.	Use wildfire historic occurrence data to demonstrate the need for the Municipality to further study and understand its risks and vulnerabilities to wildfires.
	Comprehensive Plan	Residential Policy 13-d	New rural residential subdivisions shall be designed to incorporate wildland fire safety design standards.	Use wildfire historic occurrence data to demonstrate the need for the Municipality to further study and understand its risks and vulnerabilities to wildfires.

Recommended Resilience Strategies

Based on the assessment above, the strategies summarized in Table 31 are recommended. Additional strategies can be found by referencing the FEMA publication *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards at* https://www.fema.gov/media-library/assets/documents/30627.

Table 31: Municipality of Anchorage Recommended Resilience Strategies

HAZARD	PROBLEM STATEMENT	RECOMMENDED STRATEGIES
Multi-Hazard	In the Municipality, the largest percentage of non-English-speaking residents speak Asian and Pacific languages at home, which can be attributed to the larger populations of Filipino, Korean, and Hmong residents.	• Provide outreach materials (both written and verbal) in multiple languages. • Know where vulnerable populations are located and assist with personal preparedness, appropriate evacuations, and after-event repairs.
Flood	Of the 85,378 buildings in the project area, 432 are in Zones A, AE, AH, or AO. The highest projected building losses are in Anchorage, which accounts for almost 75 percent of the losses in the Municipality. An estimated $376 million of at-risk facilities could be lost in a riverine flood event. A $376 million loss accounts for a 0.58-percent loss ratio of the studied buildings.	• Consider limiting additional development in flood hazard zones. • Develop a priority list for essential facility flood capability enhancements. • Develop a buyout program for repetitive loss properties. • Provide outreach to homeowners and business owners regarding flood risk.
Earthquake	Losses estimated from the M7.2 Intraplate Scenario event were high across all communities. The total building and content dollar loss was estimated at close to $468 million, with a municipality-wide loss ratio of 0.71 percent. Fort Richardson Military Reservation (1.15 percent) and Elmendorf Air Force Base (1.08%) have the highest loss ratios. The largest total loss values are projected for Fort Richardson Military Reservation ($3.8 million) and Elmendorf Air Force Base ($3.0 million).	• Adopt and enforce updated building code provisions that reduce earthquake risk. • Develop a priority list for essential facility earthquake retrofits. • Develop an outreach program about earthquake risk and mitigation activities for homes, schools, and businesses.
Avalanche	Eagle River and Girdwood have the largest number of buildings within avalanche hazard areas. Eagle River has 111 structures within avalanche hazard areas and Girdwood has 75 structures. Girdwood has the highest estimated building value exposure (11.49 percent). In total, the Municipality of Anchorage has 2.06 percent of structures vulnerable to potential avalanche hazard occurrences, which places over $124 million dollars at risk.	• Map avalanche risk hazard areas • Adopt and enforce building codes that set standards for building in high-risk areas. • Develop an outreach program regarding avalanche risk for homeowners, business owners, and winter sports recreation participants. • Consider structural mitigation for at-risk critical infrastructure and facilities • Maintain avalanche prevention programs. • Establish early warning capabilities and outreach mechanisms.
Dam Failure	An estimated 169 structures are identified as at risk from one of three dam failure scenarios. Loss estimations associated with the Lower Fire Lake inundation area are greater than those estimated for Eklutna Lake and Lake 'O' the Hills. The total estimated dollar loss correlating with dam failure at the Lower Fire Lake inundation area is over $13 million. Both Eklutna Lake and Lower Fire Lake inundation areas have a loss ratio of 0.01 percent; while Lake 'O' the Hills has a loss ratio of 0.00 percent.	• Map dam failure inundation areas. • Develop an outreach program on dam failure risk for homeowners and business owners. • Adopt higher regulatory floodplain standards in mapped dam failure inundation areas. • Establish early warning capability downstream of listed high-hazard dams.

HAZARD	PROBLEM STATEMENT	RECOMMENDED STRATEGIES
Landslide	Approximately $6.3 billion (5,092 improved parcels) in the studied communities are at risk from a deep, transitional landslide hazard occurrence. Only 0.11 percent of the vulnerable buildings are exposed to this type of hazard event. Anchorage and Elmendorf Air Force Military Reservation receive the majority of damages from potential landslide hazards.	• Apply stabilization measures and debris flows measures to reduce damage in sloping areas. • Restrict development in landslide zone areas. • Relocate critical infrastructure outside of landslide zones. • Develop a buyout program for homes in landslide areas. • Provide education and outreach materials to educate residents about risks.
Wind	Most of the estimated building values reside in a Zone I 3-second gust area ($26 billion). Zone I identifies areas subject to 3-second wind gusts over 100 mph. Zone II (110 mph) and Zone III (120 mph) include $15.7 and $10.1 billion in assets accordingly. Zone IV (3-second wind gust of 125 mph) contains $6.2 billion in assets. Chugiak, Eagle River, and Girdwood contain no high wind hazard data.	• Adopt and enforce building codes that set standards for building in high-wind regions. • Retrofit residential buildings and critical facilities to reduce wind damage. • Protect powerlines and infrastructure from tree branches, maintain secure power poles, and bury powerlines when possible. • Improve public awareness of severe wind through outreach activities.
Wildfire	Between 2001 and 2009, the number of wildfires per year in the Municipality of Anchorage ranged from 82 fires in 2006 to 150 fires in 2002. Between 2001 and 2006, the Municipality of Anchorage had 622 wildfire calls that burned approximately 200 acres (Anchorage All Hazards Mitigation Plan, 2011). Most recently, in the summer of 2016, 778 acres burned south of Anchorage after a campfire was left unattended (Alaska Division of Forestry).	• Study and understand the wildfire risks to ingress and egress in residential areas. • Mitigate future losses by regulating development in wildfire hazard areas through land use planning. • Develop a wildland-urban interface code to regulate for safer construction and incorporate mitigation consideration into the permitting process. • Create defensible space around structures and infrastructure. • Implement a Fuels Management Program. • Participate in the FireWise program.

While Federal funding for these projects is limited, FEMA recommends incorporating them into the Natural Hazards Mitigation Plan should disaster funds become available. Additional funding may be available through the capital improvement planning process; bond authority; or other local, State, or private funding sources. More information on how to mitigate the effects of natural hazards can be found in the FEMA *Local Mitigation Planning Handbook* at

www.fema.gov/media-library/assets/documents/31598?id=7209.

Additional information on integrating the Municipality of Anchorage HMP with the local planning process is provided in the FEMA document *Hazard Mitigation: Integrating Best Practices into Planning,* available at www.fema.gov/media-library/assets/documents/19261?id=4267.

14. References Cited

Jibson, R.W., and Michael, J.A., 2009, Maps showing seismic landslide hazards in Anchorage, Alaska: U.S. Geological Survey Scientific Investigations Map 3077, scale 1:25,000, 11-p. pamphlet. [Available at URL http://pubs.usgs.gov/sim/3077]Appendix A

Earthquake Hazus Analysis

The project team used the Hazus Advanced Engineering Building Module (AEBM) for this analysis. The underlying approach to AEBM procedures is a combination of the nonlinear static (pushover) analysis methods of the National Earthquake Hazards Reduction Program Guidelines and other sources (namely, the ATC 40 document: *Seismic* E*valuation and Retrofit of Concrete Buildings*, Applied Technology Council and California Seismic Safety Commission, 1996) with Hazus loss estimation methods. Seismic/structural engineers, having performed detailed pushover analysis of a specific building, are expected to have a much better understanding of a building's potential failure modes, overall response characteristics, structural and nonstructural system performance, and the cost required to repair damaged components.

The software architecture of the AEBM has two main components (or databases), AEBM Inventory and AEBM Profiles. The AEBM Inventory is structured to accept a "portfolio" of individual buildings, each uniquely defined by (latitude/longitude) location, and number of occupants, size, replacement cost, and other building-specific financial data. The AEBM Profiles describe an extensive set of building performance characteristics, including damage and loss function parameters. To run the AEBM, each building in the AEBM Inventory must be linked to one of the AEBM Profiles, but an AEBM Profile can be used for more than one building of the AEBM Inventory. Applications of the AEBM can be used to evaluate individual buildings or a group of buildings of a similar type.

15. Appendix B

Additional Referenced Materials

Disaster Resilience Scorecard Preliminary Review: C2ES Workshop with the City of Anchorage, AK March 29-30.

Mears, A. (1982). *Anchorage Snow Avalanche Zoning Analysis: Prepared for Municipality of Anchorage.* Gunnison, Colorado: Mears, Artheur I. P.E., Inc.

Scroggin, David A. and Batatian, L. Darlene, Avalanche Hazard Investigations, Ordinances, and Zoning, Salt Lake County, Utah. ISSW 2004.

Scroggin, David A. and Batatian, L. Darlene, Avalanche Hazard Investigations, Zoning and Ordinances, Utah, Part 2. International Snow Science Workshop, Whistler 2008.

Salt Lake County Code of Ordinances, Title 19 Zoning, Chapter 19.75 Geological Hazards Ordinance, Section 19.75.083 Avalanche Considerations.